

C/K TRUCK

1 9 9 4

Service Manual



CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed:

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of all motor vehicles. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality.

The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specifically designed for the purpose.

Accordingly, anyone who intends to use a replacement part, service procedure, or tool which is not recommended by the vehicle manufacturer, must first determine that neither his safety nor the safe operation of the vehicle will be jeopardized by the replacement part, service procedure, or tool selected.

It is important to note that this manual contains various 'Cautions' and 'Notices' that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that these 'Cautions' and 'Notices' are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

FOREWORD

This service manual contains diagnosis, on-vehicle maintenance, and light repair for C/K models. Fuel and emission-related components, along with wiring diagrams and electrical diagnosis for these models, are covered in the Driveability, Emissions, and Electrical Diagnosis Manual (NATP-9442). Procedures involving disassembly and assembly of major components for these vehicles are published in the Light Duty Truck Unit Repair Manual (NATP-9437).

CAUTION: GM service manuals are intended for use by professional, qualified technicians. Attempting repairs or service without the appropriate training, tools, and equipment could cause injury to you or others and damage to your vehicle that may cause it not to operate properly.

1994

C/K TRUCK

SERVICE MANUAL

The Table of Contents on the following page indicates the sections covered in this manual. At the beginning of each individual section is a Table of Contents which gives the page number on which each major subject begins.

When reference is made in this manual to a brand name, number, or specific tool, an equivalent product may be used in place of the recommended item.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

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Pontiac, Michigan

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GENERAL MOTORS SERVICE MANUAL COMMENTS

Technicians and Vehicle Owners & Operators:

If you find an error, omission, or have a suggestion on any General Motors Service Manual, we want to hear from you.

Starting September 1, 1993 please call:

United States—

1-800-828-6860

8:00 AM to 5:00 PM Eastern Time Zone

Canada-(General Motors Dealers Employees Only)

Quebec 1-800-263-7960, Select Option 5

Nationally 1-800-263-7740, Select Option 5

Oshawa, Ontario "Local" Area, 644-7060,
Select Option 5

8:30 AM to 5:00 PM Eastern Time Zone

These phone numbers can be called Monday through Friday. Be prepared to give the following information:

- Your name
- Your dealership's name (technicians only)
- Your phone number

- Model year and vehicle line
- Publication book number (if present)
- Vehicle Identification Number of vehicle being worked on.
- Section and page number(s)
- Description of problem

This phone number cannot provide Technical Assistance. Contact your Technical Assistance source.

The personnel who answer this phone number will provide the author of the information with your comments and will follow up until an answer is given.

If you wish to send examples or marked-up pages, the person who takes your call will tell you how to do that.

Canadian Vehicle Owner or Operator:

If you are the owner or operator of the vehicle, please give your comments to the Customer Assistance Centre. The phone number and address are in your Owner's Manual.

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0A-2 GENERAL INFORMATION

WHEN TO DISCONNECT THE NEGATIVE BATTERY CABLE

CAUTION: Before removing or installing any electrical unit or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

HANDLING ELECTROSTATIC DISCHARGE (ESD) SENSITIVE PARTS

Many solid state electrical components can be damaged by electrostatic discharge (ESD). Some will display a label, but many will not (figure 1).

In order to avoid possibly damaging any components, observe the following:

1. Body movement produces an electrostatic charge. To discharge personal static electricity, touch a ground point (metal) on the vehicle. This should be done any time you:
 - Slide across the vehicle seat.
 - Sit down or get up.
 - Do any walking.
2. Do not touch exposed electric terminals on components with your finger or any tools. Remember, the connector that you are checking might be tied into a circuit that could be damaged by electrostatic discharge.
3. When using a screwdriver or similar tool to disconnect a connector, never let the tool come in contact with or come between the exposed terminals.
4. Never jumper, ground, or use test equipment probes on any components or connectors unless specified in diagnosis. When using test equipment, always connect the ground lead first.
5. Do not remove the solid state component from its protective packaging until you are ready to install the part.
6. Always touch the solid state components package to a ground before opening. Solid state components can also be damaged if:

- They are bumped or dropped.
- They are laid on any metal work benches or components that operate electrically, such as a TV, radio, or oscilloscope.

SPECIAL TOOL ORDERING INFORMATION

Special service tools shown in this service manual that have tool product numbers beginning with "J" or "BT" are available for worldwide distribution from:

Kent-Moore
SPX Corporation
29784 Little Mack
Roseville, MI 48066-2298
1-800-345-2233
Mon.-Fri. 8:00 p.m. EST
Telex: 244040 KMTR VR
Fax: 313-578-7375

General Motors dealers can purchase TECH 1 scan tools and accessories through Kent-Moore at the above address and phone number. Non-General Motors dealer repair facilities can purchase TECH 1 scan tools and accessories from Kent-Moore at the above address or :

Sun Electric Corporation
One Sun Parkway
Crystal Lake, IL 60014
1-800-CALLSUN (225-5786)
6:45 a.m. - 7:00 p.m. CST

VEHICLE CERTIFICATION LABEL

The vehicle certification label indicates the GVWR (Gross Vehicle Weight Rating), front and rear GAWR (Gross Axle Weight Rating), and the payload rating for the vehicle (figures 2 and 3).

The gross vehicle weight (GVW) is the weight of the originally equipped vehicle and all items added to it after it has left the factory. This would include bodies, winches, booms, etc., the driver and all occupants, and the load the vehicle is carrying. The gross vehicle weight (GVW) must not exceed the gross vehicle weight rating (GVWR). Also, the front and rear gross axle weights (GAW) must not exceed the front and rear GAWR (Gross Axle Weight Rating).

The payload rating shown on the label is the maximum allowable cargo load (including the weight of the driver and all occupants) that the vehicle can carry

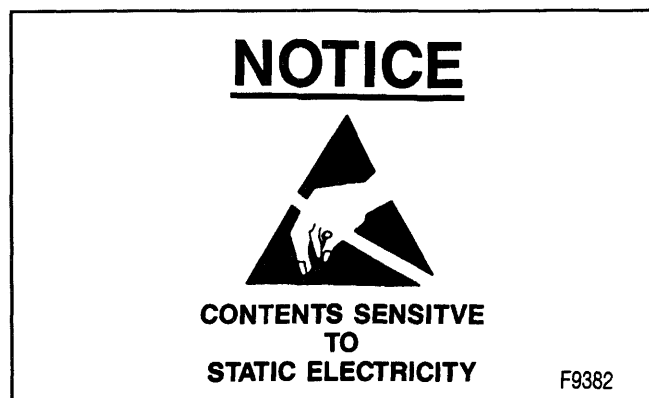


Figure 1—Electrostatic Discharge Symbol

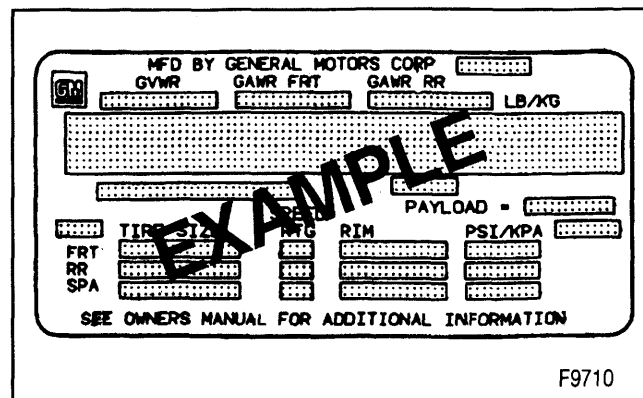


Figure 2—Complete Vehicle Certification Label

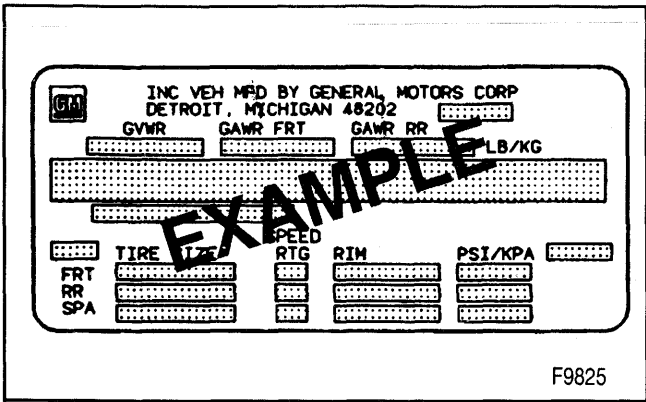


Figure 3—Incomplete Vehicle Certification Label

based on all factory installed equipment on the vehicle. The payload rating is reduced if any accessories or other equipment are added to the vehicle after final date of manufacture. The weight of these items should be determined and deducted from the payload rating.

The vehicle may also have a GCWR (Gross Combination Weight Rating). The GCWR (Gross Combination Weight Rating) is the total weight of the loaded tow vehicle (including passengers) and a loaded trailer.

The tires on the vehicle must be the proper size and properly inflated for the load which you are carrying. The vehicle certification label shows the originally equipped tire size and recommended inflation pressures. For more information on tires, refer to SECTION 3E.

VEHICLE IDENTIFICATION NUMBER

The vehicle identification number (VIN) is the seventeen digit legal identifier of the vehicle. It is located on a plate which is attached to the left top of the instrument panel and can be seen through the windshield (figure 4). To find the manufacturer, model and chassis type, engine type, GVW (Gross Vehicle Weight) range, model year, plant code, and sequential number, refer to figure 5.

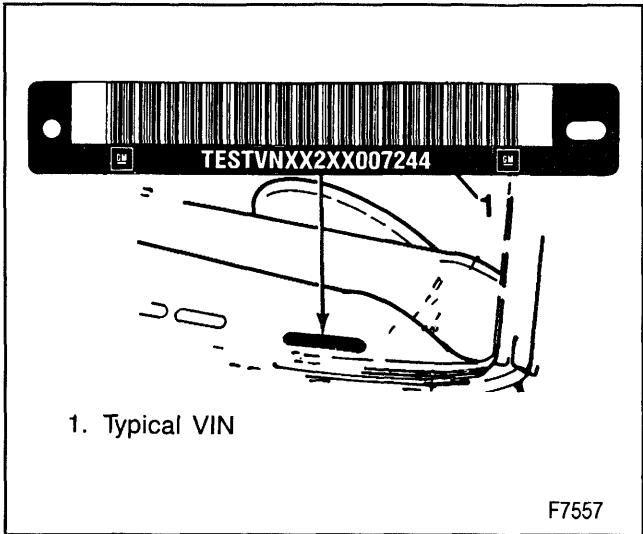


Figure 4—Vehicle Identification Number (VIN) Location

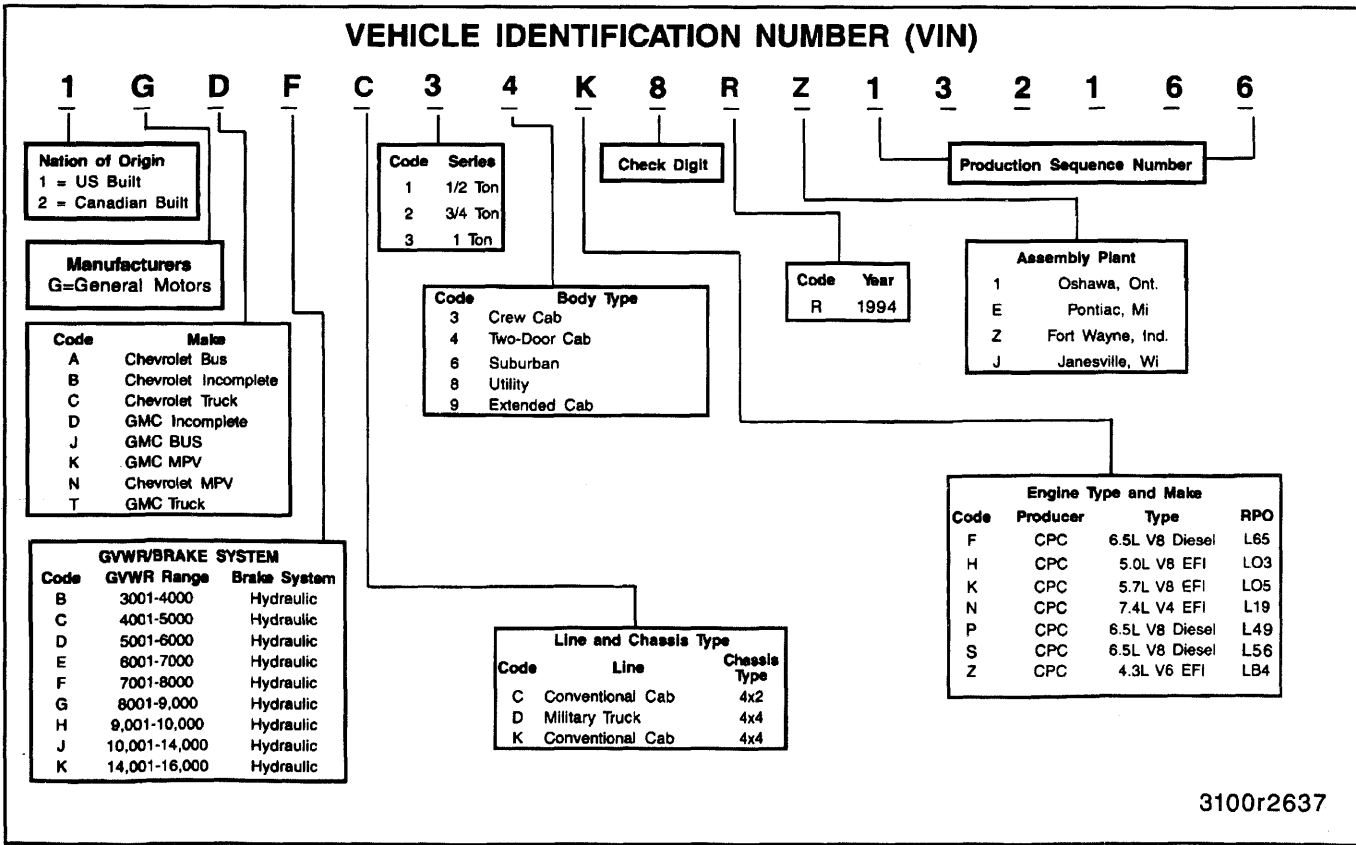


Figure 5—Vehicle Identification Chart

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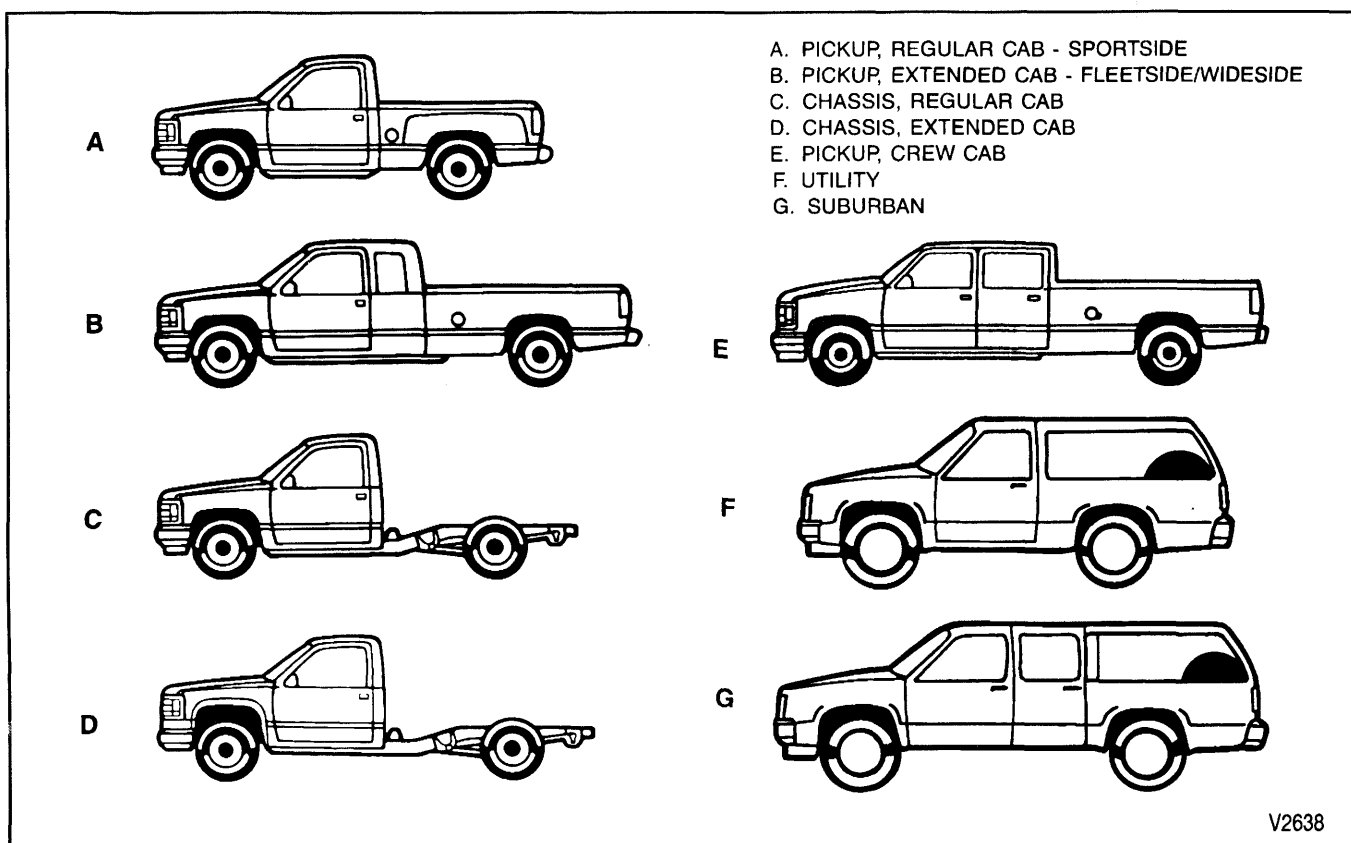


Figure 6—Model Identification

MODEL IDENTIFICATION

Models and body styles are shown in figure 6.

ENGINE IDENTIFICATION NUMBER

The VIN provides detailed engine identification and code information by liter and by the engine code letter located on the vehicle identification plate.

Stick-on labels attached to the engine, or laser etching or stampings on the engine block, indicate the engine unit number or date code.

All engines are stamped with an engine identification number. The stamping contains eight positions (figures 7, 8, 9, and 10).

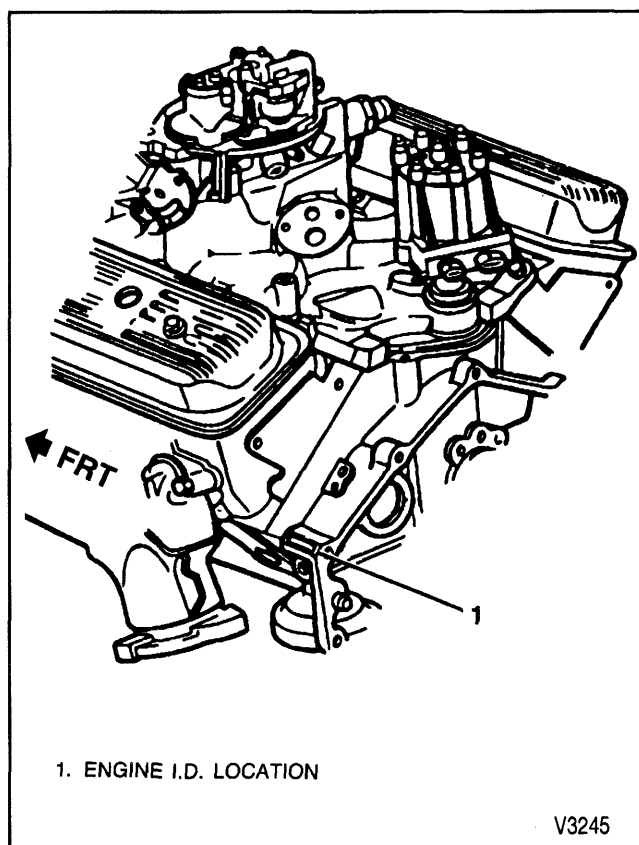


Figure 7—4.3L Engine I.D. Location

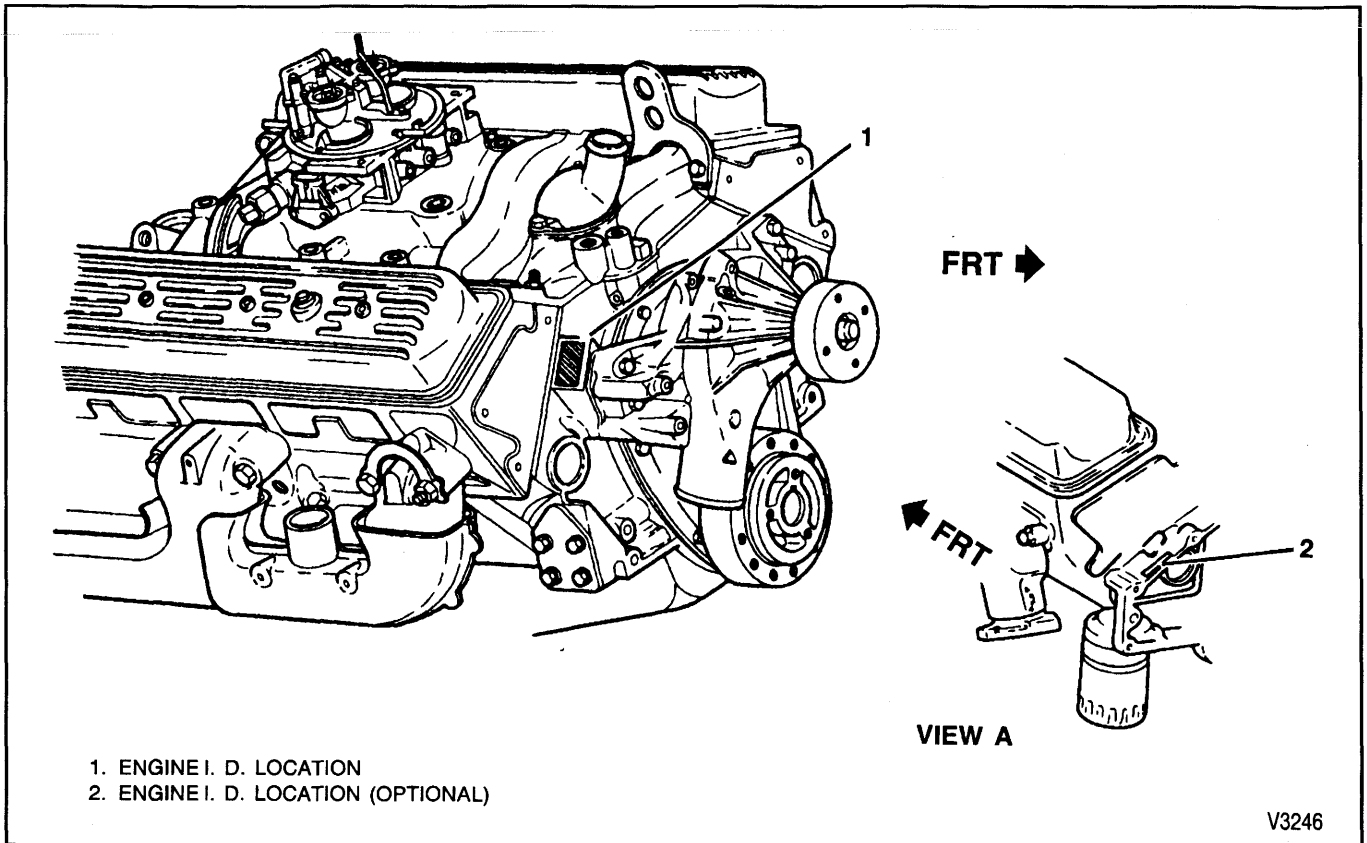


Figure 8—5.0L and 5.7L Engine I.D. Location

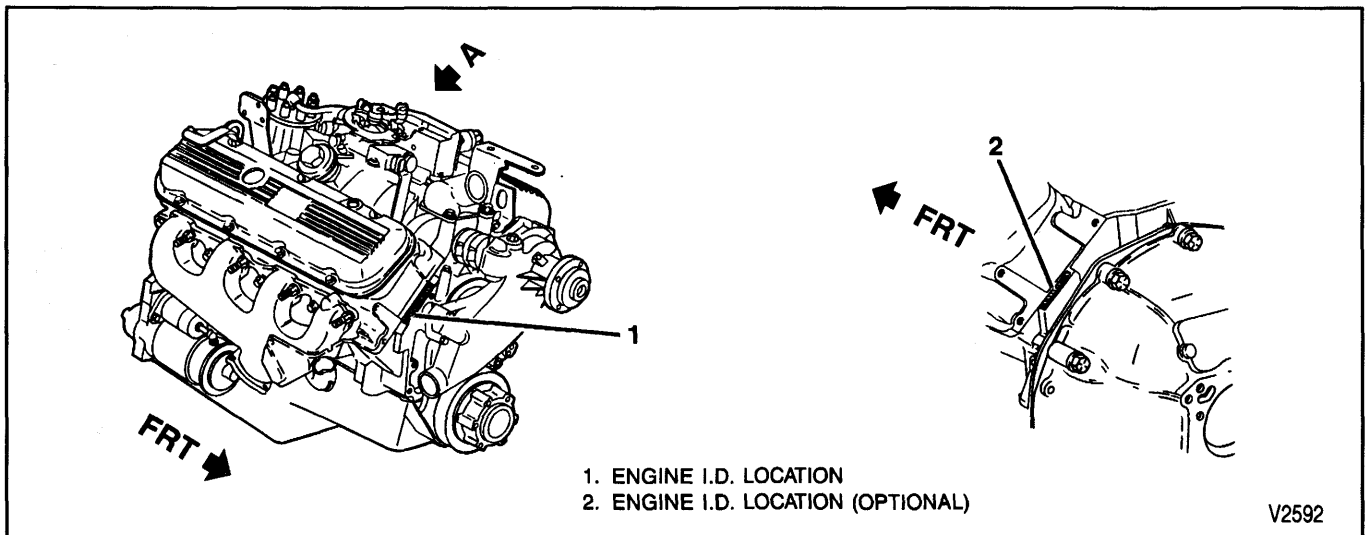


Figure 9—7.4L Engine I.D. Location

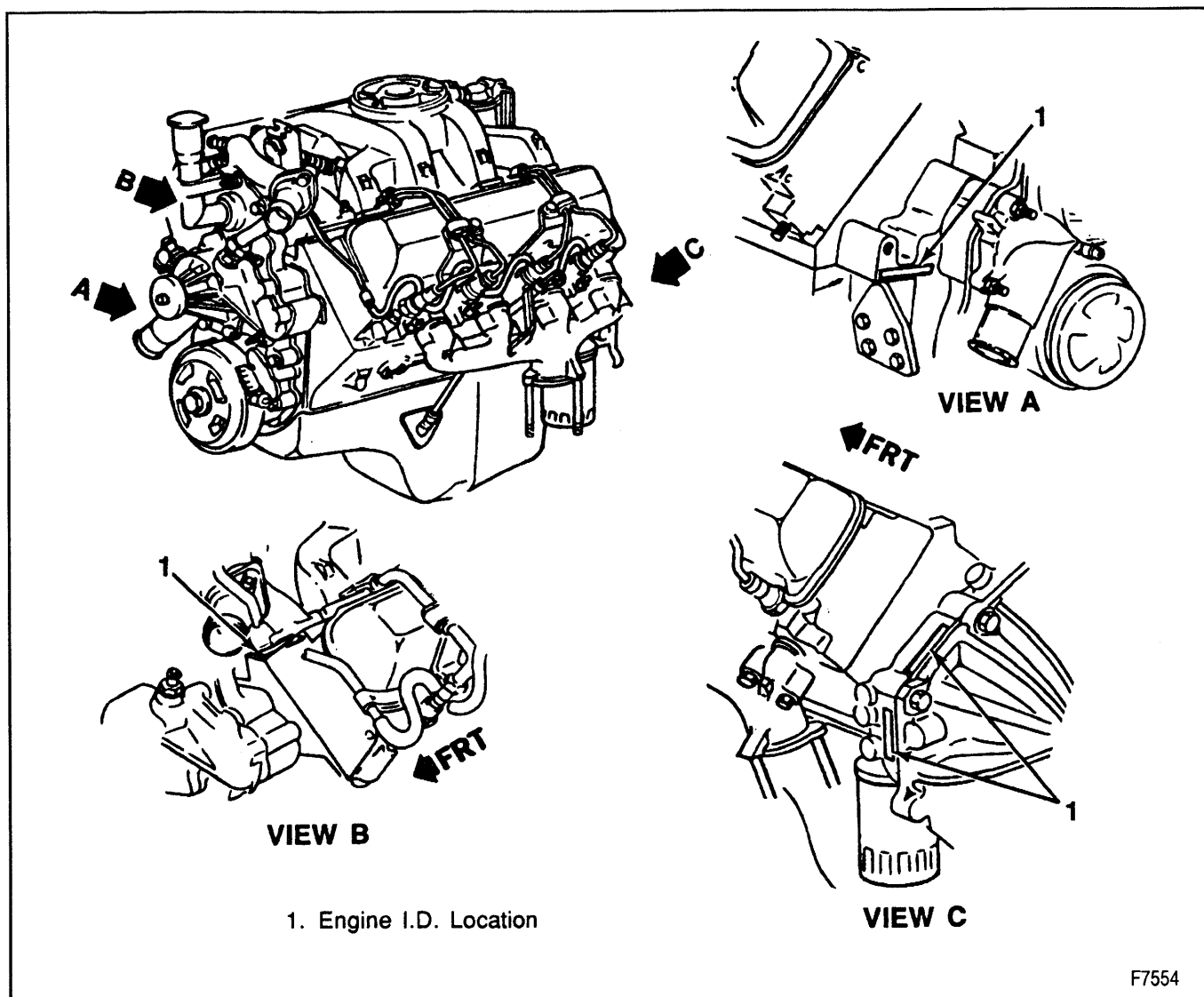


Figure 10—6.5L Diesel Engine I.D. Location

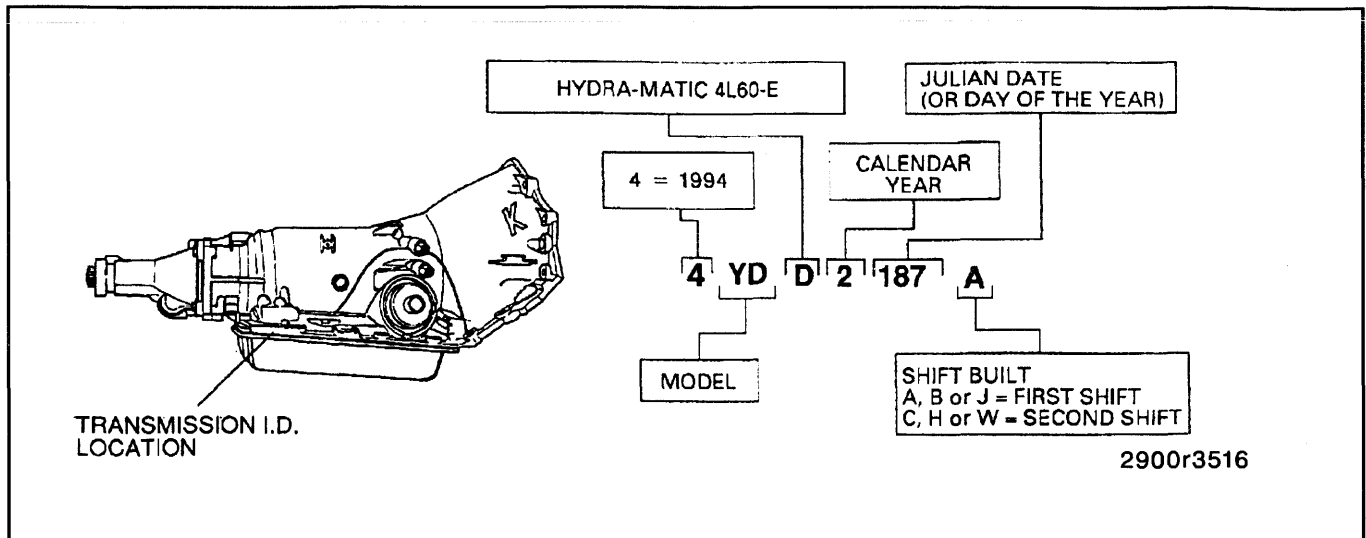


Figure 11—Hydra-Matic 4L60-E Transmission I.D.Location

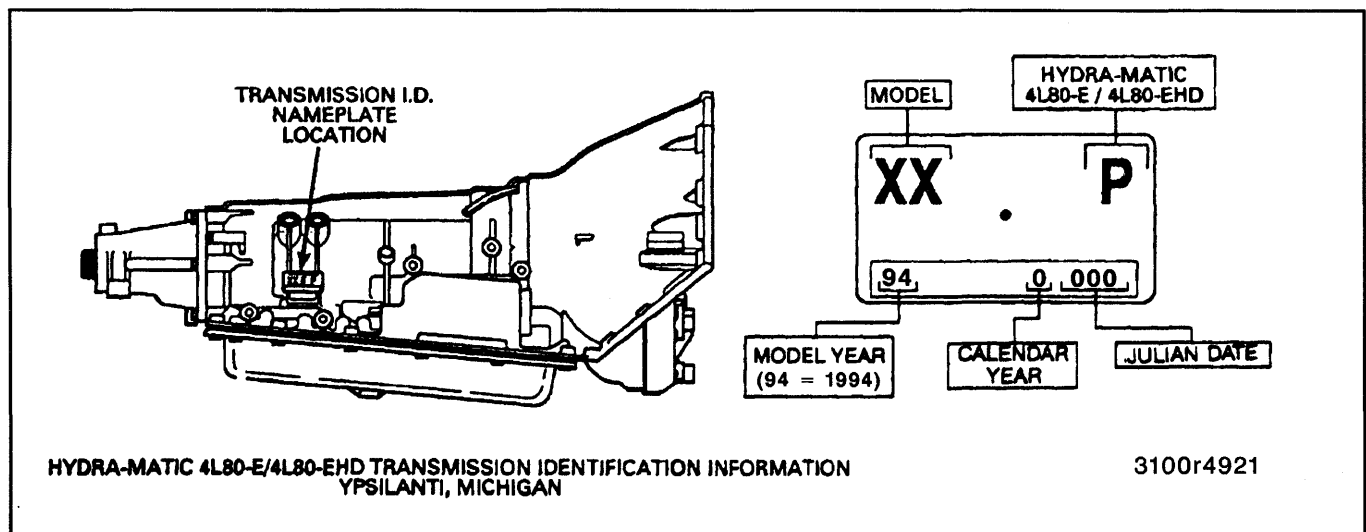
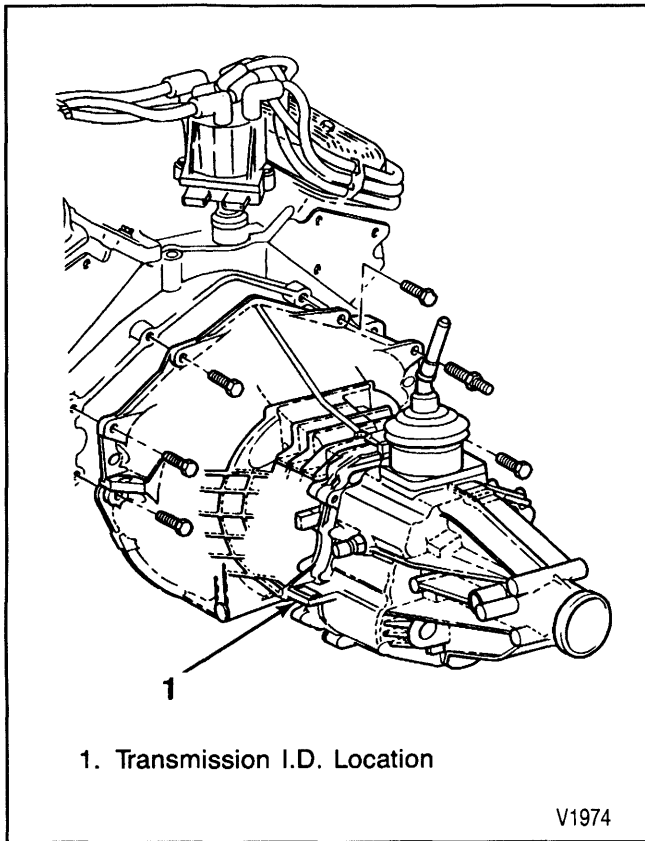


Figure 12—Hydra-Matic 4L80-E Transmission I.D. Location

TRANSMISSION IDENTIFICATION NUMBER

Manual and automatic transmission model identification is located on a label or tag applied to the transmission case. If the label or tag is missing or unreadable, use the Service Parts Identification label to determine which transmission was installed in the vehicle (figures 11 through 15).

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**Figure 13—New Venture Gear 3500 (5LM60)
Transmission I.D. Location**

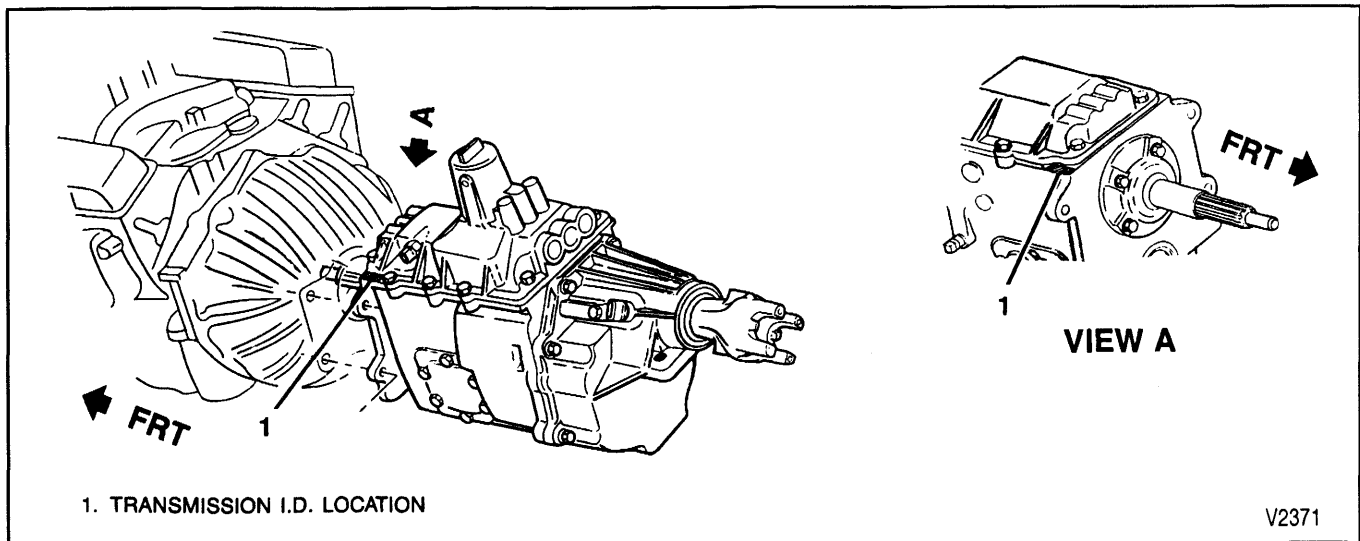


Figure 14—New Venture Gear 4500 Transmission I.D. Location

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Model	Engine		Transmission	
	Base	Option	Base	Option
C107 (03)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05)	5 Spd. Manual (MG5)	4 Spd. Auto (M30) 5 Spd. Manual (MG5)
C107 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L49) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1) 4 Spd. Auto (M30) 5 Spd. Manual (MG5)
C109 (03)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L56) 6.5L V8 (L49)	5 Spd. Manual (MG5)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1) 4 Spd. Auto (M30) 5 Spd. Manual (MG5)
C109 (06)	5.7L V8 (L05)	6.5L V8 (L56)	4 Spd. Auto (M30)	4 Spd. Auto (MT1)
C109 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L49) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 4 Spd. Auto (MT1) 5 Spd. Manual (MT8) 4 Spd. Auto (M30)
C207 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 4 Spd. Auto (MT1) 5 Spd. Manual (MT8) 4 Spd. Auto (M30)
C209 (03)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 7.4L V8 (L19) 6.5L V8 (L49) 6.5L V8 (L56) 6.5L V8 (L65)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 5 Spd. Manual (MT8) 4 Spd. Auto (M30) 4 Spd. Auto (MT1)
C209 (06)	5.7L V8 (L05)	6.5L V8 (L65)	4 Spd. Auto (MT1)	4 Spd. Auto (MT1)
C209 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 7.4L V8 (L19) 6.5L V8 (L49) 6.5L V8 (L56) 6.5L V8 (L65)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 5 Spd. Manual (MT8) 4 Spd. Auto (M30) 4 Spd. Auto (MT1)
C309 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
C309 (43)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
C309 (53)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
C310 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
C314 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
C318 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
K105 (16)	5.7L V8 (L05)	6.5L V8 (L56)	5 Spd. Manual (MG5)	4 Spd. Auto (M30) 4 Spd. Auto (MT1)
K107 (03)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 4 Spd. Auto (MT1) 5 Spd. Manual (MT8) 4 Spd. Auto (M30)
K107 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L49) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 4 Spd. Auto (MT1) 5 Spd. Manual (MT8) 4 Spd. Auto (M30)
K109 (03)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L49) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 4 Spd. Auto (MT1) 5 Spd. Manual (MT8) 4 Spd. Auto (M30)

0A-10 GENERAL INFORMATION

Model	Engine		Transmission	
	Base	Option	Base	Option
K109 (06)	5.7L V8 (L05)	6.5L V8 (L56)	4 Spd. Auto (M30)	4 Spd. Auto (MT1)
K109 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L49) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MT8) 4 Spd. Auto (M30) 4 Spd. Auto (MT1)
K207 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 6.5L V8 (L49) 6.5L V8 (L56)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 5 Spd. Manual (MT8) 4 Spd. Auto (M30) 4 Spd. Auto (MT1)
K209 (03)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 7.4L V8 (L19) 6.5L V8 (L49) 6.5L V8 (L56) 6.5L V8 (L65)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 5 Spd. Manual (MT8) 4 Spd. Auto (M30) 4 Spd. Auto (MT1)
K209 (06)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	4 Spd. Auto (MT1)	4 Spd. Auto (MT1)
K209 (53)	4.3L V6 (LB4)	5.0L V8 (L03) 5.7L V8 (L05) 7.4L V8 (L19) 6.5L V8 (L49) 6.5L V8 (L56) 6.5L V8 (L65)	5 Spd. Manual (MG5)	5 Spd. Manual (MG5) 5 Spd. Manual (MT8) 4 Spd. Auto (M30) 4 Spd. Auto (MT1)
K309 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
K309 (43)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
K309 (53)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
K310 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)
K314 (03)	5.7L V8 (L05)	7.4L V8 (L19) 6.5L V8 (L65)	5 Spd. Manual (MT8)	5 Spd. Manual (MT8) 4 Spd. Auto (MT1)

Model Codes:

C—Two-Wheel Drive
K—Four-Wheel Drive
03—Two Door Cab
06—Four Door Suburban

16—Two Door Utility
43—Four Door Cab
53—Two Door Extended Cab

T2960

Figure 15—Engine and Transmission Application

GENERAL VEHICLE LIFTING AND JACKING

CAUTION: When a vehicle is on a hoist, support the vehicle at the opposite end from which components are being removed in order to reduce the possibility of the vehicle falling off the hoist and causing personal injury.

NOTICE: When jacking or lifting a vehicle, be certain that the lift pads do not contact the catalytic converter, brake lines, brake cables, or fuel lines. Such contact may result in damage or unsatisfactory vehicle performance.

When removing major components from the vehicle while the vehicle is on a hoist, the vehicle frame should

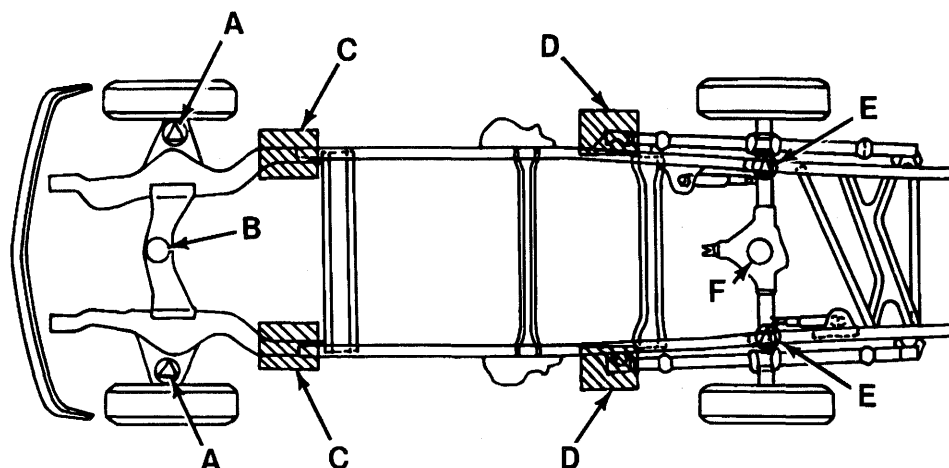
be chained to the hoist pads at the same end as the removed components in order to prevent tip-off and personal injury.

VEHICLES WITHIN 11,000 LBS. GVWR

NOTICE: Do not attempt to use a hoist to lift a vehicle equipped with a camper body. The weight distribution of the body may make the vehicle unstable during hoisting and cause damage to the frame.

The only lift points for these vehicles are shown in figures 16 and 17, and are described in the following paragraphs.

When lifting a C or K model vehicle with a hoist, the front pads should be positioned under the frame rails, just forward of the second crossmember. The rear pads should be positioned under the rear spring front brackets.



- A. Lower control arm; inboard of the lower ball joint.
- B. Center of front suspension crossmember.
- C. Frame at forward edge of crossmember.
- D. Rear spring at front bracket.
- E. Rear axle just inboard of the spring.
- F. Rear axle at the center of the differential case.

F2916

Figure 16—Chassis Lift Points—C Models (6,000 to 11,000 Lb. GVWR)

When lifting a C model vehicle front end with a floor jack, position the jack pad under the lower control arm and inboard from the ball joint. The C model vehicle front end can also be lifted by positioning the floor jack pad under the center of the front crossmember.

When lifting a C model vehicle front end with a vehicle jack, position the jack under the lower control arm and inboard from the ball joint.

When lifting a C or K model vehicle rear end with a floor jack, position the jack pad either between the spring pad and the shock absorber hanger or under the axle differential case.

When lifting a C or K model vehicle rear end with a vehicle jack, position the jack pad between the spring pad and the shock absorber hanger.

When lifting a K model vehicle front end with a floor jack, position the jack pad either under the middle of the front crossmember or under the lower control arm at the lowest point of the control arm.

Any time a vehicle is lifted with a vehicle jack or a floor jack, the wheels at the opposite end of the lifted end should be chocked. Also, jack stands should be used to provide support. When supporting the vehicle with jack stands, the jack stands should be placed under the frame, the front suspension crossmember, or the axle.

When removing major components from the vehicle while the vehicle is on a hoist, the vehicle frame should be chained to the hoist pads in order to prevent tip-off.

VEHICLES WITHIN 12,000 OR 15,000 LBS. GVWR

Lifting With A Hoist:

Do not attempt to lift either of these vehicles with a single-post hoist. Single-post hoists are not rated to lift vehicles of these weights. The 12,000 lb. GVWR vehicle may be lifted with a wheel hoist if the hoist is rated for more than 12,000 lbs.

A twin-post hoist can be used, provided each post is rated for more than the GAWR of the vehicle being lifted. This is particularly true for the rear axle. The addition of various types of bodies and other equipment to the original cab chassis may have resulted in heavier GAWRs than indicated on the certification label.

If the 12,000 lb. GVWR vehicle is being lifted, place the front hoist supports at the lower control arms, inboard of the lower ball joints. Place the rear support at the axle tube.

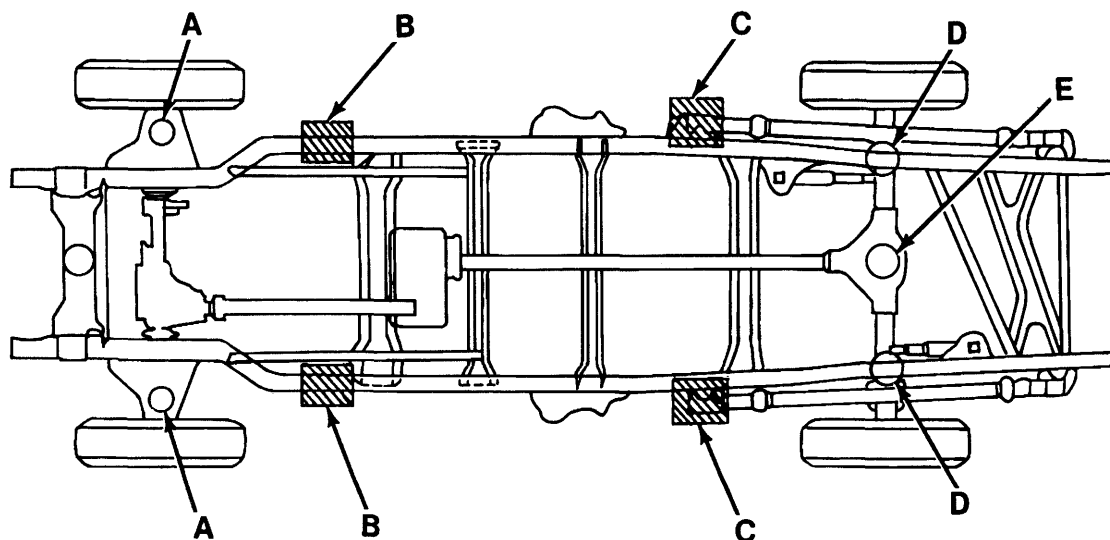
If the 15,000 lb. GVWR vehicle is being lifted, the front support can be placed under the I-beam front axle. Place the rear support under the axle tube.

When removing major components from the vehicle while the vehicle is on a hoist, the vehicle frame should be chained to the hoist pads in order to prevent tip-off.

Lifting with a Floor Jack:

NOTICE: Do not attempt to use an in-vehicle type jack, such as a bumper or scissors jack, on the 15,000 lb. GVWR vehicle. These jacks are not strong enough for the weight of the vehicle, and could collapse suddenly, causing damage to the vehicle.

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- A. Lower Control Arm; Inboard of the Lower Ball Joint
- B. Frame Just Forward of the Crossmember
- C. Rear Spring at Front Bracket
- D. Rear Axle Just Inboard of the Spring Mount
- E. Rear Axle at the Center of the Differential Case

F3513

Figure 17—Chassis Lift Points—K Models (6,000 to 11,000 Lb. GVWR)

When lifting the front end of the vehicle with a floor jack, position the jack pad under the frame rail just rearward of the body mount or under the lower control arm and inboard from the ball joint. The 15,000 lb. GVWR vehicle can also be lifted under the front axle.

When lifting the rear end of the vehicle, position the jack pad under the rear axle between the spring attachment and shock bracket.

Any time a vehicle is lifted with a vehicle jack or a floor jack, the wheels at the opposite end of the lifted end should be chocked. If jack stands are also used for support, they may only be placed just rearward of the body mounts. Do not place jack stands under the rear section of the frame or under any crossmember.

LOCK CYLINDER CODING

KEY IDENTIFICATION AND USAGE

The lock cylinder keyway is designed so that other model keys will not enter a current model lock cylinder. Two non-interchangeable keys are used. The square-headed key is used in the ignition lock cylinder. The oval-headed key is used in all other lock cylinders.

Key identification is obtained from the four-character key code stamped on the knockout portion of the key head and an identification letter stamped on the key shank. After the code number has been recorded by the owner, the plugs should be knocked out of the key head. From these numbers, the lock combination can be determined by use of a code list. This list is available to owners of key cutting equipment from equipment suppliers. If the key code numbers are not

available from records or from the knockout plug, the lock combination (tumbler numbers and position) can be determined by laying the key on the diagram in figure 18.

CUTTING KEYS

1. Determine the code from the code list or the key code diagram (figure 18).
2. Cut a blank key to the proper level for each of six tumbler positions.
3. Check the key operation in the lock cylinder.

REPLACEMENT LOCK CYLINDERS

Lock cylinders are available from service parts warehouses. The new cylinder has a locking bar staked in place. Tumblers are also available and must be assembled into the cylinder.

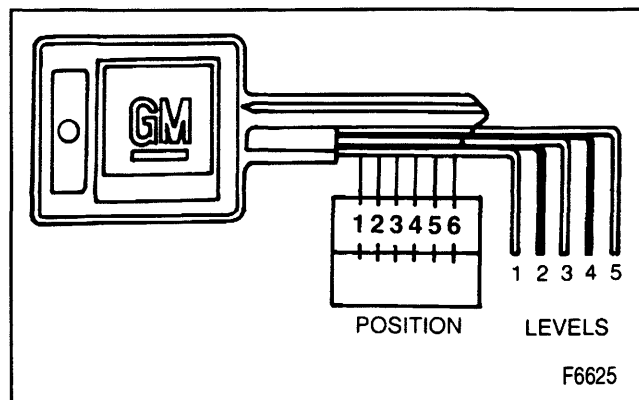


Figure 18—Key Code Diagram

ASSEMBLING AND CODING LOCK CYLINDERS

All Lock Cylinders Except Instrument Panel Compartment

Tumblers for all locks are shaped exactly alike with the exception of the notch position on one side. As the key is inserted in the lock cylinder, tumblers are lowered to the correct heights so that notches on each tumbler are at the same level. When the notches on all tumblers line up, the side bar is pushed into the notches by two small springs. This allows the cylinder to turn in its bore. Five types of tumblers are used to make the various lock combinations. Each tumbler is coded according to a number, 1 through 5, stamped on its side.



Assemble (Figures 19 and 20)

1. Determine the tumbler numbers and arrangement.
 - With the numerical key code, use the code list provided by a key cutting equipment supplier.
 - Without the numerical key code or without a code list, refer to figure 18.
 - A. Lay the key on the key code diagram. Be sure the key is outlined by the diagram.
 - B. Start with position number one. Find and record the lowest level (tumbler number) that is visible. Repeat for each of the remaining five positions.
2. Starting with position one (the open end or head of the cylinder), insert tumblers in their proper slots in the order called for by the code (figure 19).
3. Pull the side bar out so that the tumblers will drop completely into place.
4. Insert one tumbler spring above each tumbler.

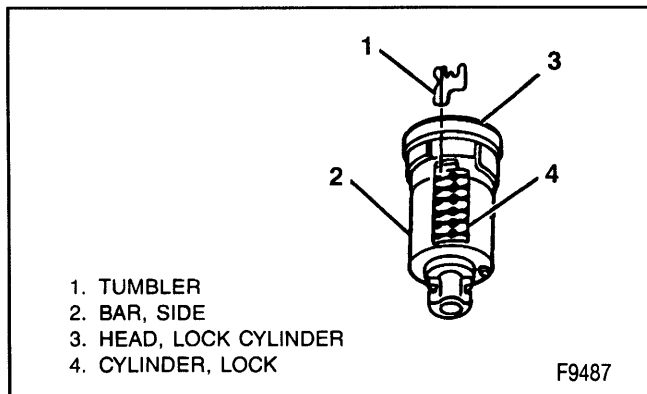


Figure 19—Installing Tumblers

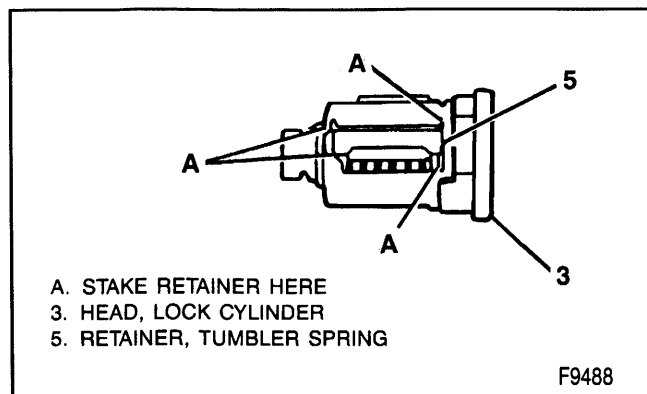


Figure 20—Installing Spring Retainer

5. Insert the spring retainer so that the end prongs slide into the slots at each end of the cylinder. Press the retainer down (figure 20).
6. Insert the key into the lock cylinder to check for proper installation. If the tumblers are installed properly, the side bar will drop down. If it doesn't, take the cylinder apart and reassemble it.

NOTICE: Use leather or wood at each vise jaw to prevent damage to the cylinder.

7. Remove the key, and secure the cylinder in a vise with the spring retainer exposed.
8. Stake the spring retainer securely in place at each end. Use a suitable staking tool, and stake the cylinder metal over the retainer.
9. Lock cylinders should be lubricated with GM multi-purpose lubricant P/N 12345120 or with a light oil (5W30).

Instrument Panel Compartment Lock Cylinder

A lock cylinder with snap-in tumblers is used for the instrument panel compartment lock (figures 21 and 22). The lock cylinder has four or five tumbler positions. The

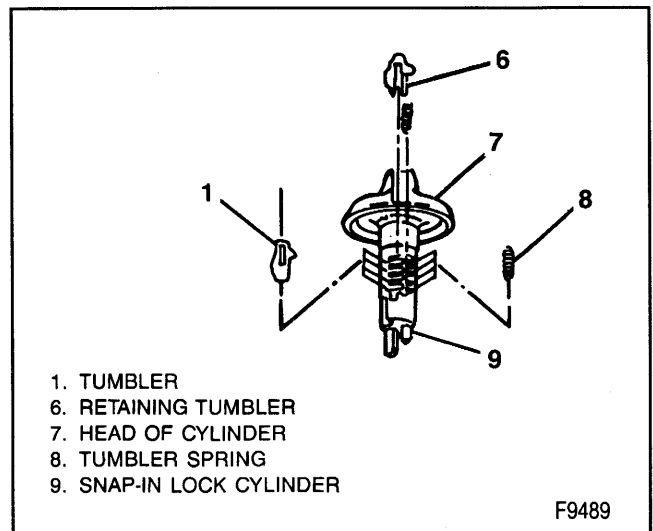


Figure 21—Installing Tumblers

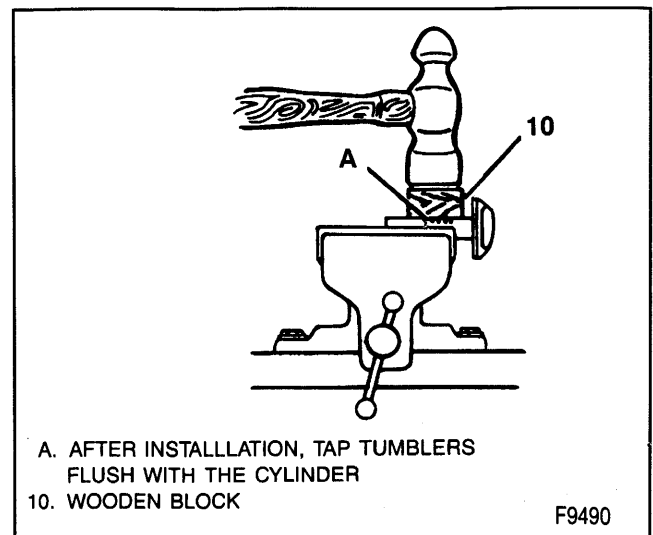


Figure 22—Locking the Tumblers in Place

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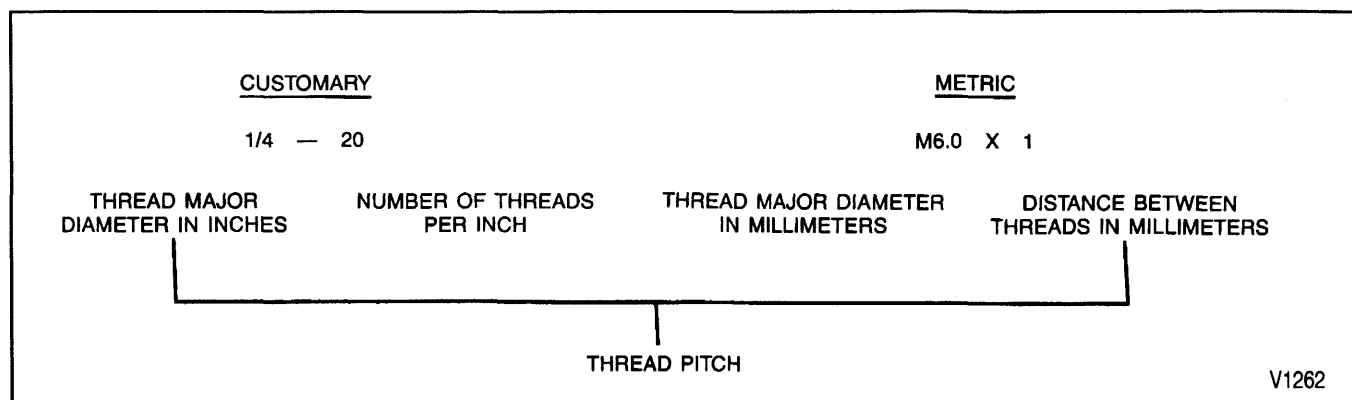


Figure 23—Thread Notation

number 1 or 2 position (closest to the cylinder head) is a brass retainer tumbler. The 2 through 5 positions or 3 through 5 positions are standard tumbler positions depending on cylinder type. Therefore, only the last 4 or 5 tumbler combinations are required. To assemble the lock cylinder, determine the tumbler numbers and arrangement as previously described and install the tumblers.

METRIC FASTENERS

Current model GM vehicles are primarily dimensioned in the metric system. Many fasteners are metric and are very close in dimension to well-known customary fasteners in the inch system. It is most important that replacement fasteners be of the correct nominal diameter, thread pitch, and strength.

Original equipment metric fasteners (except "beauty" bolts, such as exposed bumper bolts and cross-recess head screws) are identified by a number of markings indicating the strength of the material in the fastener as outlined later. Metric cross-recess screws are identified by a Posidriv or Type 1A. Either a Phillips head or Type 1A cross-recess screwdriver can be used in Posidriv recess screw heads, but Type 1A cross-recess screwdrivers will perform better.

! Important

- Most metric fasteners have a blue color coating. However, this should not be used as positive identification, as some fasteners are not color coated.

General Motors Engineering Standards, along with other North American Industries, has adopted a portion of the standard metric fastener sizes defined by ISO (International Standards Organization). This was done to reduce the number of fastener sizes used and yet retain the best strength qualities in each thread size. For example, the customary 1/4-20 and 1/4-28 screws are replaced by the metric M6.0X1 screw which has nearly the same diameter and has 25.4 threads per inch. The thread pitch is in between the customary coarse and fine thread pitches.

Metric and customary thread notation differ slightly. The difference is described in figure 23.

FASTENER STRENGTH IDENTIFICATION

Most commonly used metric fastener strength property classes are 9.8 and 10.9 with the class identification embossed on the head of each bolt. Customary (inch) strength classes range from grade 2 to 8 with radial line identification embossed on each bolt head. Markings correspond to two lines less than the actual grade (i.e., grade 7 bolt will exhibit 5 embossed radial lines on the bolt head). Some metric nuts will be marked with single digit strength identification numbers on the nut face. To review the different strength markings available, refer to figure 24.

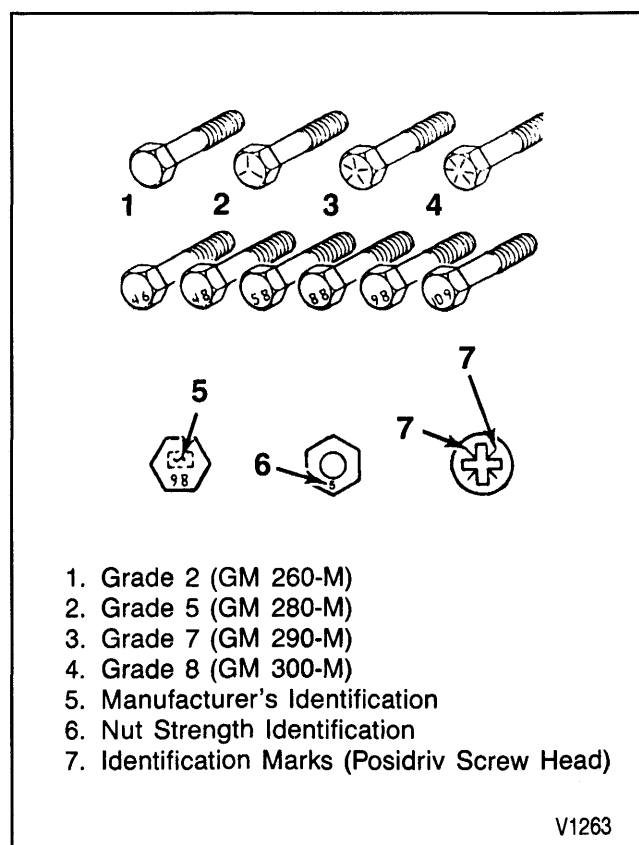


Figure 24—Fastener Strength Markings (Identification)

When replacing metric fasteners, be careful to use bolts and nuts of the same strength or stronger than the original fasteners (the same number marking or higher). Likewise, it is important to select replacement fasteners of the correct size. Correct replacement bolts metric fasteners available in the aftermarket parts channels were designed to metric standards of countries other than the United States, and may be of a lower strength, may not have the numbered head marking system, and may be of a different thread pitch. The metric fasteners used on GM products are designed to new, international standards that may not yet be manufactured by some non-domestic bolt and nut suppliers.

PREVAILING TORQUE FASTENERS

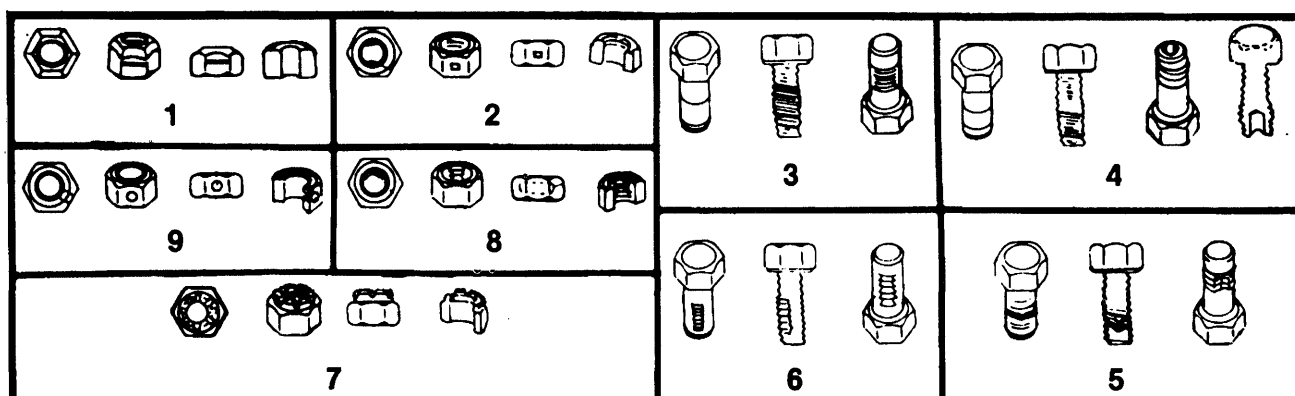
A prevailing torque nut is designed to develop an interference between the nut and bolt threads. This is most often accomplished by distortion of the top of an all-metal nut by using a nylon patch on the threads in the middle of the hex flat. A nylon insert may also be used as a method of interference between nut and bolt threads (figure 25).

A prevailing torque bolt is designed to develop an interference between bolt and nut threads, or the

threads of a tapped hole. This is accomplished by distorting some of the threads or by using a nylon patch or adhesive.

Recommendations For Reuse:

- Clean, unruined, prevailing torque nuts and bolts may be reused as follows:
 - Clean dirt and other foreign material off the nut or bolt.
 - Inspect the nut or bolt to ensure there are no cracks, elongation, or other signs of abuse or overtightening. (If there is any doubt, replace with a new prevailing torque fastener of equal or stronger strength.)
 - Assemble the parts, and hand start the nut or bolt.
 - Observe that, before fastener seats, it develops torque per the chart in figure 25. (If there is any doubt, replace with a new prevailing torque fastener of equal or stronger strength.)
 - Tighten the fastener to the torque specified in the appropriate section of this manual.
- Bolts and nuts which are rusty or damaged should be replaced with new parts of equal or stronger strength.



A									
		6 & 6.3	8	10	12	14	16	20	
4, 5	N·m	0.4	0.8	1.4	2.2	3.0	4.2	7.0	
	In. Lbs.	4.0	7.0	12	18	25	35	57	
1, 2, 3, 6, 7, 8, 9	N·m	0.4	0.6	1.2	1.6	2.4	3.4	5.6	
	In. Lbs.	4.0	5.0	10	14	20	28	46	
B									
		.250	.312	.375	.437	.500	.562	.625	.750
4, 5	N·m	0.4	0.6	1.4	1.8	2.4	3.2	4.2	6.2
	In. Lbs.	4.0	5.0	12	15	20	27	35	51
1, 2, 3, 6, 8, 9	N·m	0.4	0.6	1.0	1.4	1.8	2.6	3.4	5.2
	In. Lbs.	4.0	5.0	9.0	12	15	22	28	43

A. Metric Sizes
B. Inch Sizes

1. Top Lock Type
2. Center Lock
3. Dry Adhesive Coating
4. Out Of Round Thread
5. Deformed Thread Profile

6. Nylon Strip Or Patch
7. Nylon Washer Insert
8. Nylon Patch
9. Nylon Insert

B2406

Figure 25—Prevailing Torque Nuts and Bolts

**METRIC-ENGLISH
CONVERSION**

For determining metric-english conversions, refer to figure 26.

CONVERSION TABLE

to get equivalent number of:			to get equivalent number of:		
Multiply	by		Multiply	by	
LENGTH			ACCELERATION		
Inch	25.4	millimeters (mm)	Foot/sec ²	0.304 8	meter/sec ² (m/s ²)
Foot	0.304 8	meters (m)	Inch/sec ²	0.025 4	meter/sec ²
Yard	0.914 4	meters	TORQUE		
Mile	1.609	kilometers (km)	Pound-inch	0.112 98	newton-meters (N·m)
AREA			Pound-foot	1.355 8	newton-meters
Inch ²	645.2	millimeters ² (mm ²)	POWER		
	6.45	centimeters ² (cm ²)	Horsepower	0.746	kilowatts (kW)
Foot ²	0.092 9	meters ² (m ²)	PRESSURE OR STRESS		
Yard ²	0.836 1	meters ²	Inches of water	0.249 1	kilopascals (kPa)
VOLUME			Pounds/sq. in.	6.895	kilopascals
Inch ³	16.387	mm ³	ENERGY OR WORK		
	16.387	cm ³	BTU	1 055	joules (J)
	0.016 4	liters (l)	Foot-pound	1.355 8	joules
Quart 0.946 4		liters	Kilowatt-hour	3 600 000	joules (J $\doteq$ one W)
Gallon	3.785 4	liters		or 3.6 x 10 ⁶	
Yard ³	0.764 6	meters ³ (m ³)	LIGHT		
MASS			Foot candle	1.076 4	lumens/meter ² (lm/m ²)
Pound	0.453 6	kilograms (kg)	FUEL PERFORMANCE		
Ton	907.18	kilograms (kg)	Miles/gal	0.425 1	kilometers/liter (km/l)
Ton	0.907	tonne (t)	Gal/mile	2.352 7	liter/kilometer (l/km)
FORCE			VELOCITY		
Kilogram	9.807	newtons (N)	Miles/hour	1.609 3	kilometers/hr. (km/h)
Ounce	0.278 0	newtons			
Pound	4.448	newtons			
TEMPERATURE					
Degree Fahrenheit	$(^{\circ}\text{F}-32) \div 1.8$				
	degree Celsius (C)				

Figure 26—Metric-English Conversion Table

DECIMAL AND METRIC EQUIVALENTS

For determining decimal and metric equivalents, refer to figure 27.

J1930 WORD CONVERSION

Starting with the 1993 model year, General Motors will be complying with the Society of Automotive Engineers (SAE) Recommended Practice J1930. J1930 is

an industry-wide standard that was adopted into government regulations and requires certain electrical and electronic components and systems be known by the same nomenclature that have the same function. This standard is also being applied to abbreviations and acronyms. This standard is being used in all GM service publications.

To make this standard work, some names and abbreviations are being replaced with those recommended by the SAE standard.

DECIMAL AND METRIC EQUIVALENTS					
Fractions	Decimal In.	Metric mm	Fractions	Decimal In.	Metric mm
1/64	0.015625	0.39688	33/64	0.515625	13.09687
1/32	0.03125	0.79375	17/32	0.53125	13.49375
3/64	0.046875	1.19062	35/64	0.546875	13.89062
1/16	0.0625	1.58750	9/16	0.5625	14.28750
5/64	0.078125	1.98437	37/64	0.578125	14.68437
3/32	0.09375	2.38125	19/32	0.59375	15.08125
7/64	0.109375	2.77812	39/64	0.609375	15.47812
1/8	0.125	3.1750	5/8	0.625	15.87500
9/64	0.140625	3.57187	41/64	0.640625	16.27187
5/32	0.15625	3.96875	21/32	0.65625	16.66875
11/64	0.171875	4.36562	43/64	0.671875	17.06562
3/16	0.1875	4.76250	11/16	0.6875	17.46250
13/64	0.203125	5.15937	45/64	0.703125	17.85937
7/32	0.21875	5.55625	23/32	0.71875	18.25625
15/64	0.234375	5.95312	47/64	0.734375	18.65312
1/4	0.250	6.3500	3/4	0.750	19.05000
17/64	0.265625	6.74687	49/64	0.765625	19.44687
9/32	0.28125	7.14375	25/32	0.78125	19.84375
19/64	0.296875	7.54062	51/64	0.796875	20.24062
5/16	0.3125	7.93750	13/16	0.8125	20.63750
21/64	0.328125	8.33437	53/64	0.828125	21.03437
11/32	0.34375	8.73125	27/32	0.84375	21.43125
23/64	0.359375	9.12812	55/64	0.859375	21.82812
3/8	0.375	9.52500	7/8	0.875	22.22500
25/64	0.390625	9.92187	57/64	0.890625	22.62187
13/32	0.40625	10.31875	29/32	0.90625	23.01875
27/64	0.421875	10.71562	59/64	0.921875	23.41562
7/16	0.4375	11.11250	15/16	0.9375	23.81250
29/64	0.453125	11.50937	61/64	0.953125	24.20937
15/32	0.46875	11.90625	31/32	0.96875	24.60625
31/64	0.484375	12.30312	63/64	0.984375	25.00312
1/2	0.500	12.7000	1	1.00	25.40000

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Figure 27—Decimal and Metric Equivalents

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For determining J 1930 word conversions, refer to figure 28.

J1930 CONVERSION CHART	
From	To
Absolute Pressure Sensor (APS)	Manifold Absolute Pressure Sensor (MAPSensor)
Accelerator (ACCEL)	Accelerator Pedal (AP)
Air Cleaner Assembly	Air Cleaner (ACL)
Air Cleaner Filter Element	Air Cleaner Filter (ACL Filter)
Air Induction System	Air Intake System
Air Injection Reaction System (A.I.R. System)	Secondary Air Injection System (AIR System)
Assembly Line Communication Link (ALCL)	Data Link Connector (DLC)
Assembly Line Data Link (ALDL)	Data Link Connector (DLC)
BCM-PCM Data Problem	BCM-PCM Data Link
Calibration Pack (CAL-PAK)	1. Electronically Erasable Programmable Read Only Memory (EEPROM) 2. Erasable Programmable Read Only Memory (EPROM) 3. Programmable Read Only Memory (PROM)
Camshaft Sensor	Camshaft Position Sensor (CMP Sensor)
Canister Purge (CP)	Evaporative Emission Canister Purge (EVAP Canister Purge)
Catalytic Converter (Cat. Conv.)	1. Oxidation Catalytic Converter (OC) 2. Three Way Catalytic Converter (TWC) 3. Three Way and Oxidation Catalytic Converter (TWC&OC) 4. Warmup Oxidation Catalytic Converter (WU-OC) 5. Warmup Three Way Catalytic Converter (WU-TWC)
Check Engine Indicator	Malfunction Indicator Lamp (MIL)
Code	Diagnostic Trouble Code (DTC)
Computer Controlled Coil Ignition (C3I)	Electronic Ignition (EI)
Computer Command Control (CCC)	Engine Control Module (ECM)
Controlled Canister Purge (CCP)	Evaporative Emission Canister Purge (EVAP Canister Purge)
Coolant Temperature Switch (CTS)	Engine Coolant Temperature Switch (ECT Switch)
Coolant Temperature Sensor (CTS)	Engine Coolant Temperature Sensor (ECT Sensor)
Cooling Fan Control	Cooling Fan Control (Cooling FC)
Detonation Sensor	Knock Sensor (KS)
Diagnostic Circuit Check	Onboard Diagnostic System Check (OBD System Check)
Digital Fuel Injection (DFI)	1. Multiport Fuel Injection (MFI) 2. Sequential Multiport Fuel Injection (SFI)
Digital Electronic Fuel Injection (DEFI)	1. Multiport Fuel Injection (MFI) 2. Sequential Multiport Fuel Injection (SFI)
Direct Ignition System (DIS)	Electronic Ignition System (EI System)
Distributor HEI Module	Distributor Ignition Control Module (DI Control Module)
Distributorless Ignition System (DIS)	Electronic Ignition (EI)
Dual Bed Monolith (DBM)	1. Oxidation Catalytic Converter (OC) 2. Three Way Catalytic Converter (TWC)
Electric Air Control (EAC)	Secondary Air Injection Bypass Valve (AIR Bypass Valve)
Electric Air Switching (EAS)	Secondary Air Injection Switching Valve (AIR Switching Valve)
Electronic Control Module (ECM)	Engine Control Module (ECM)
Electronic Fuel Injection	1. Multiport Fuel Injection (MFI) 2. Sequential Multiport Fuel Injection (SFI) 3. Throttle Body Fuel Injection (TBI)
Electronic Spark Timing (EST)	Ignition Control (IC)
Electronic Spark Timing Circuit (EST Circuit)	Ignition Control Circuit (IC Circuit)

J1930 CONVERSION CHART	
From	To
Electronic Spark Timing System (EST System)	Distributor Ignition System (DI System)
Electronic Spark Control Circuit (ESC Circuit)	Knock Sensor Circuit (KS Circuit)
Electronic Spark Control System (ESC System)	Knock Sensor System (KS System)
Electronic Vacuum Regulator Valve (EVRV)	Exhaust Gas Recirculation Electronic Vacuum Regulator Solenoid Valve
Engine Calibration Unit (ECU)	Programmable Read Only Memory (PROM)
Evaporative Emission Control System (EECS)	Evaporative Emission Control System (EVAP Control System)
Evaporative Emission Control System (EECS)	Evaporative Emission System (EVAP System)
Exhaust Gas Recirculation/Thermostatic Vacuum Switch (EGR/TVS)	Exhaust Gas Recirculation Thermal Vacuum Valve (EGR TVV)
Fuel Cal-Pak Missing	PROM Missing
Generator (Gen)	Generator (GEN)
Governor	Engine Speed Governor (RPM Governor)
High Energy Ignition (HEI)	Distributor Ignition (DI)
Lean Exhaust	1. Heated Oxygen Sensor Signal (HO2S Signal) 2. Oxygen Sensor Signal (O2S Signal)
Manifold Air Temperature Sensor (MAT Sensor)	Intake Air Temperature Sensor (IAT Sensor)
Mem-Cal Error	1. EPROM Error 2. PROM Error
Memory and Calibration Unit (MEM-CAL)	1. Erasable Programmable Read Only Memory (EPROM) 2. Programmable Read Only Memory (PROM)
Mixture Control (M/C)	Mixture Control (MC)
Multi-Port Fuel Injection (MPFI)	Multiport Fuel Injection (MFI)
Nitrogen Oxides (NO _x)	Nitrogen Oxides (NO _x)
Oxygen (O ₂)	Oxygen (O2)
Oxygen Sensor (O2)	1. Heated Oxygen Sensor (HO2S) 2. Oxygen Sensor (O2S)
Park/Neutral Switch (P/N Switch)	Park/Neutral Position Switch (PNP Switch)
Port Fuel Injection (PFI)	Multiport Fuel Injection (MFI)
Power Steering (P/S)	Power Steering (PS)
Power Steering Switch	Power Steering Pressure Switch (PSP Switch)
Pulse Air Injection System (PAIR)	Pulsed Secondary Air Injection System (PAIR System)
Revolutions Per Minute (RPM)	Engine Speed (RPM)
Rich Exhaust	1. Heated Oxygen Sensor Signal (HO2S Signal) 2. Oxygen Sensor Signal (O2S Signal)
"Scan" Data	Scan Tool Data (ST Data)
Sequential Fuel Injection (SFI)	Sequential Multiport Fuel Injection (SFI)
Sequential-port Fuel Injection (SFI)	Sequential Multiport Fuel Injection (SFI)
Service Engine Soon Indicator (SES Indicator)	Malfunction Indicator Lamp (MIL)
Thermal Vacuum Switch (TVS)	Thermal Vacuum Valve (TVV)
Thermostatic Air Cleaner (TAC)	Air Cleaner (ACL)
Throttle Body Injection (TBI)	Throttle Body Fuel Injection (TBI)
Throttle Switch	1. Closed Throttle Position Switch (CTP Switch) 2. Wide Open Throttle Switch (WOT Switch)
Throttle Position Sensor (TPS)	Throttle Position Sensor (TP Sensor)
Throttle Position Switch (TPS)	1. Closed Throttle Position Switch (CTP Switch) 2. Wide Open Throttle Switch (WOT Switch)
Tuned Port Injection (TPI)	Multiport Fuel Injection (MFI)
Transmission/Transaxle Converter Clutch (TCC)	Torque Converter Clutch (TCC)
Viscous Converter Clutch (VCC)	Torque Converter Clutch (TCC)

T2934

Figure 28—J 1930 Conversion Chart

ABBREVIATIONS

AC—Alternating Current
A/C—Air Conditioning
ACL—Air Cleaner
ADJ—Adjust
A/F—Air Fuel Ratio
AIR—Secondary Air Injection
Alt—Altitude
AMP—Ampere(s)
ANT—Antenna
AP—Accelerator Pedal
ASM—Assembly
AT—Automatic Transmission
ATDC—After Top Dead Center
Auth—Authority
Auto—Automatic
BARO—Barometric Pressure
Bat—Battery
B+—Battery Positive Voltage
BP—Back Pressure
BTDC—Before Top Dead Center
°C—Degrees Celsius
CAC—Charge Air Cooler
Calif—California
CCOT—Cycling Clutch Orifice Tube
CD—Compact Disc
CFI—Continuous Fuel Injection
CID—Cubic Inch Displacement
CKP—Crankshaft Position
CL—Closed Loop
CMP—Camshaft Position
CO—Carbon Monoxide
Coax—Coaxial
Conn—Connector
Conv—Converter
CPP—Clutch Pedal Position
CPS—Central Power Supply
Crank—Crankshaft
CTP—Closed Throttle Position
CV—Constant Velocity
Cyl—Cylinder(s)
DC—Direct Current
DFI—Direct Fuel Injection
Diff—Differential
DI—Distributor Ignition
Dist—Distributor
DLC—Data Link Connector
DTC—Diagnostic Trouble Code
DTM—Diagnostic Test Mode
DVM—Digital Voltmeter (10 meg.)
EAC—Electric Air Control
EAS—Electric Air Switching
ECL—Engine Coolant Level
ECM—Engine Control Module
ECT—Engine Coolant Temperature
ECU—Engine Calibration Unit (PROM)
EEPROM—Electrically Erasable Programmable
Read Only Memory
EFE—Early Fuel Evaporation
EGR—Exhaust Gas Recirculation
EGR TVV—Exhaust Gas Recirculation Thermal
Vacuum Valve
EI—Electronic Ignition

EM—Engine Modification
EPROM—Erasable Programmable Read Only Memory
ESC—Electronic Spark Control
ESD—Electrostatic Discharge
ETR—Electronically Tuned Receiver
EVAP—Evaporative Emission
EXH—Exhaust
°F—Degrees Fahrenheit
FC—Fan Control
FED—Federal (All States Except Calif.)
GAL—Gallon
GEN—Generator
Gov—Governor
g—Gram
GND—Ground
Harn—Harness
HC—Hydrocarbons
HD—Heavy Duty
Hg—Mercury
HiAlt—High Altitude
HO2S—Heated Oxygen Sensor
IAC—Idle Air Control
IAT—Intake Air Temperature
IC—Ignition Control
ICM—Ignition Control Module
ID—Identification or Inside Diameter
IFI—Indirect Fuel Injection
IGN—Ignition
ILC—Idle Load Compensator
INJ—Injection
IP—Instrument Panel
IPC—Instrument Panel Cluster
INT—Intake
ISC—Idle Speed Control
km—Kilometer
km/h—Kilometer per hour
kPa—KiloPascals
KS—Knock Sensor
kV—Kilovolts (thousands of volts)
L—Liter
LF—Left Front
LH—Left Hand
LR—Left Rear
LS—Left Side
L4—Four Cylinder In-Line engine
MAF—Mass Air Flow
MAN—Manual
MAP—Manifold Absolute Pressure
MAT—Manifold Air Temperature
Max—Maximum
MC—Mixture Control
MDP—Manifold Differential Pressure
MFI—Multiport Fuel Injection
MIL—Malfunction Indicator Lamp
Min—Minimum
mL—Milliliter
mm—Millimeter
MPG—Miles Per Gallon
MPH—Miles Per Hour
MST—Manifold Surface Temperature
mV—MilliVolt
NC—Normally Closed
N.m—Newton Meters
NO—Normally Open

NOx—Nitrogen, Oxides of
NVRAM—Non-Volatile Random Access Memory
OBD—On-Board Diagnostic
OC—Oxidation Catalytic Converter
OD—Outside Diameter
OL—Open Loop
O2—Oxygen
O2S—Oxygen Sensor
PAIR—Pulse Secondary Air Injection
P/B—Power Brakes
PCM—Powertrain Control Module
PCV—Positive Crankcase Ventilation
PNP—Park/Neutral Position
PRESS—Pressure
PROM—Programmable Read Only Memory
PS—Power Steering
psi—Pounds per Square Inch
Pt—Pint
PTO—Power Takeoff
PWM—Pulse Width Modulated
Qt—Quart
RAM—Random Access Memory
REF—Reference
RF—Right Front
RFI—Radio Frequency Interference
RH—Right Hand
ROM—Read Only Memory
RPM—Engine Speed
RPO—Regular Production Option
RR—Right Rear
RS—Right Side
RTV—Room Temperature Vulcanizing
RVB—Rear Vacuum Break
RVR—Response Vacuum Reducer
SAE—Society of Automotive Engineers
Sec—Secondary
SFI—Sequential Multiport Fuel Injection
SI—System International
Sol—Solenoid
SPEC—Specification
Speedo—Speedometer
SPL—Smoke Puff Limiter
SRI—Service Reminder Indicator
SRT—System Readiness Test
ST—Scan Tool
SYN—Synchronize
TAC—Thermostatic Air Cleaner
Tach—Tachometer
TB—Throttle Body
TBI—Throttle Body Fuel Injection
TCC—Torque Converter Clutch
TCM—Transmission Control Module
TDC—Top Dead Center
Term—Terminal

Thermo—Thermostatic Air Cleaner
TEMP—Temperature
TP—Throttle Position
TRANS—Transmission
TV—Throttle Valve
TVRS—Television & Radio Suppression
TVV—Thermal Vacuum Valve
TWC—Three Way Catalytic Converter
TWC+OC—Three Way + Oxidation Catalytic Converter
U-Joint—Universal Joint
V—Volt(s)
VAC—Vacuum
VAF—Volume Air Flow
VDOT—Variable Displacement Orifice Tube
VIN—Vehicle Identification Number
VR—Voltage Regulator
V-ref—ECM Reference Group
VRV—Vacuum Reducer Valve
VSS—Vehicle Speed Sensor
V6—Six Cylinder "V" Engine
V8—Eight Cylinder "V" Engine
w/—With
w/b—Wheel Base
w/o—Without
WOT—Wide Open Throttle
WU-OC—Warmup Oxidation Catalytic Converter
WU-TWC—Warmup Three Way Catalytic Converter

REPLACEMENT LABELS

Replacement labels are available through GM Service Parts Operations (SPO) for the following:

- Vehicle Emission Control Information (Exhaust Emission Tune-Up)
- Spare Wheel Caution
- Jacking
- Spare Tire Storage
- Serpentine Belt Routing
- Engine Fan Caution

These and other labels will be found in the Standard Parts Catalog.

The Vehicle Certification Label, Tire Pressure Placard, and Service Parts Identification Label are **NOT** available as service parts.

SERVICE PARTS IDENTIFICATION LABEL

The Service Parts Identification Label has been developed and placed on the vehicle to aid service and parts personnel in identifying parts and options originally installed on the vehicle (figure 29).

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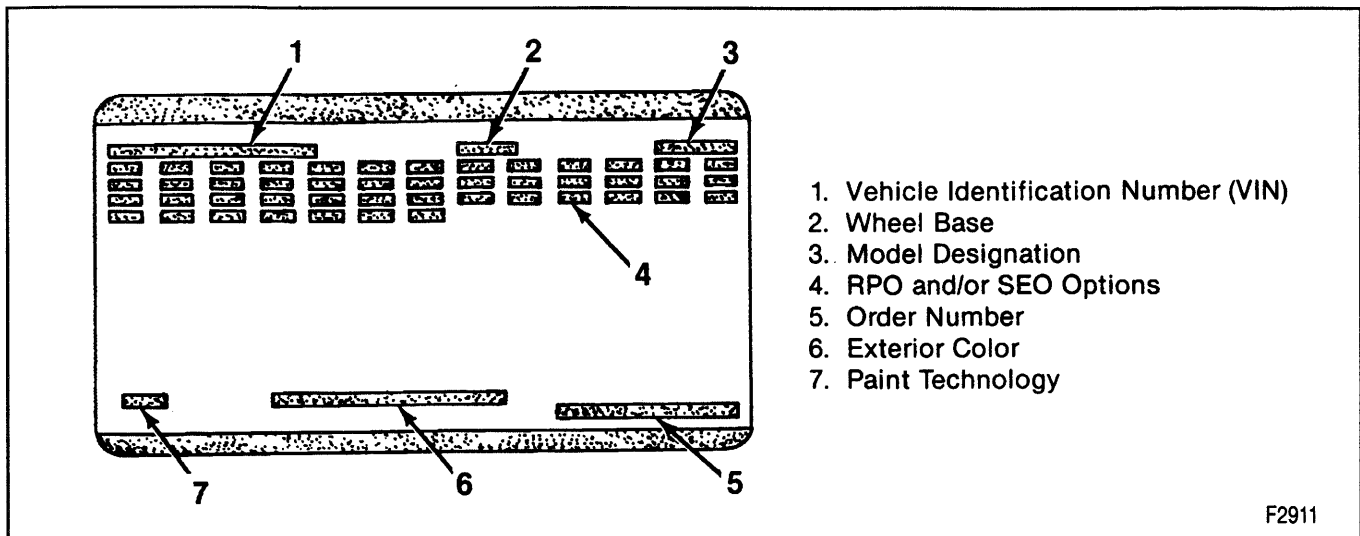


Figure 29—Service Parts Identification Label

OPTION AND PROCESS CODES

AE7	Seating: 40/60 Split Front Bench	C6U	9000 Lbs. GVW Rating
AG9	Seat Adjuster: Power, 6 Way	C6W	9200 Lbs. GVW Rating
AJ1	Window: Deep Tint, All Except Windshield and Door Glass	C6Y	9600 Lbs. GVW Rating
AK9	Restraint System: Rear Seat Shoulder	C60	Air Conditioning: Front, Manual
AM7	Seat: Rear Folding Bench	C69	Air Conditioning: Rear, Roof Mounted
AS3	Rear Seat: Suburban	C7A	10,000 Lbs. GVW Rating
ATZ	Rear Seat: Delete	C7E	11,000 Lbs. GVW Rating
AT5	Rear Seat: Center, Folding	C7I	6450 Lbs. GVW Rating
AU3	Lock: Side Door, Electric	C7L	12,000 Lbs. GVW Rating
AU6	Lock: Tailgate, Elect. Release	C95	Roof Lamp: Courtesy, Dual Reading
A20	Window: Rear Quarter Vent, Swing Out	DF2	Mirrors Exterior: Camper Type, Stainless Steel
A28	Window: Rear Full Width, Sliding	DG5	Mirrors Exterior: West Coast Type, Stainless Steel
A31	Window: Side, Power	DK6	Console: Instrument, Roof
A50	Seat: Front Bucket	DR1	Mirrors, Exterior: LH & RH Man. Cont., Painted
A52	Seat: Front Folding Bench	D44	Mirrors, Exterior: Below-Eye-Line Type, Black
A82	Head Restraint System	D45	Mirrors, Exterior: Below Eyeline, Bright
A95	Front Bucket Seats, High Back and Reclining	D48	Mirrors, Exterior: Electric, Painted
BG9	Covering: Floor, Rubber	D55	Console: Frt. Compt., Floor
BYP	Sales: Sport Equipment Package	E55	Endgate: Suburban
B3J	Diesel Equipment	E62	Pickup Box: Sportside/Stepside
B32	Floor Mats: Front Removable, Color Keyed	E63	Pickup Box: Fleetside
B33	Floor Mats: Rear Removable, Color Keyed	FF4	Torsion Bar Spring Adjust Arm, Left
B37	Covering: Floor Mats, Frt. & Rear, Aug	FF5	Torsion Bar Spring Adjust Arm, Right
B71	Moldings: Wheel Opening, Colored	FF6	Torsion Bar Spring Adjust Arm, Left
B85	Moldings: Bright Body Side	FF7	Torsion Bar Spring Adjust Arm, Right
B96	Moldings: Chrome Wheel Opening	FF8	Torsion Bar Spring Adjust Arm, Left
C3F	7700 Lbs. GVW Rating	FF9	Torsion Bar Spring Adjust Arm, Right
C25	Wiper System: Rear Window	FK2	Torsion Bar Spring Adjust Arm, Left
C36	Heater: Auxiliary	FK3	Torsion Bar Spring Adjust Arm, Right
C49	Defogger: Rear Window, Electric	FWI	Plant Code: Fort Wayne, IN
C5B	15,000 Lbs. GVW Rating	F44	Chassis Equipment, Heavy Duty
C5G	5600 Lbs. GVW Rating	F51	Shock Absorbers: Front & Rear, Heavy Duty
C5I	8050 Lbs. GVW Rating	F60	Springs, Front: Heavy Duty
C5M	6100 Lbs. GVW Rating	F61	Rear Stabilizer Shaft
C5P	6250 Lbs. GVW Rating	GK9	Axle: Rear, 4.63 Ratio
C5S	6600 Lbs. GVW Rating	GMC	Plant Code: Pontiac, MI
C5U	6800 Lbs. GVW Rating	GQ1	Axle: Rear, Standard Ratio
C5Z	7200 Lbs. GVW Rating	GTY	Rear Axle, Wide Track
C6P	8600 Lbs. GVW Rating	GT4	Axle: Rear, 3.73 Ratio

GT5	Axle: Rear, 4.10 Ratio	QB5	Wheel: 16X16.5, Steel, H.D.
GU4	Axle: Rear, 3.08 Ratio	QHA	Tire: All, P235/75R15/X BW R/PE ST TL ALS
GU6	Axle: Rear, 3.42 Ratio	QHB	Tire: All, P235/75R15/X WS2 R/PE ST TL ALS
G50	Spring: Rear, Heavy Duty, Variation 1	QHP	Tire: All, LT225/75R16/D BW R/PE ST TL ALS
G80	Axle, Rear: Limited Slip Differential	QHR	Tire: All, LT225/75R16/D BW R/PE ST TL OOR
HC4	Axle: Rear, 4.56 Ratio	QIT	Tire: All, LT245/75R16/C BL R/PE ST TL ALS
HC7	Axle: Rear, 5.13 Ratio	QIW	Tire: All, LT245/75R16/E BL R/PE ST TL OOR
JAN	Plant Code: Janesville, WI.	QIX	Tire: All, LT265/75R16/C BL R/PE ST TL OOR
JB5	Power Brake, Disc/Drum, 6400 Lbs.	QIY	Tire: All, LT265/75R16/C WOL R/PE ST TL OOR
JB6	Power Brakes, Disc/Drum, 7200 Lbs.	QIZ	Tire: All, LT245/75R16/E BL R/PE ST TL OOR
JB7	Power Brakes, Disc/Drum, 8400 Lbs.	QJV	Tire: All, LT225/75R16/C BL R/PE ST TL ALS
JB8	Power Brakes, Disc/Drum, 10,000 Lbs.	Q4B	6200 Lbs. GVW Rating
JD5	Dual Power Brakes, Disc/Drum, 6400 Lbs.	R04	Wheels, Rear: Single
JD6	Hydraulic Power Brakes, Disc/Drum, 7200 Lbs.	R05	Wheels, Rear: Dual
JD7	Hydraulic Power Brakes, Disc/Drum, 8400 Lbs.	SVA	Holder: Cup, I/P Mounted
JF9	Hydraulic Power Brakes, 4 Wheel Discs	TP2	Battery: Auxiliary, Camper
KC4	Cooling System: Engine Oil	TR9	Lighting, Auxiliary
KL5	Conversion: Natural Gas	TS6	Lamp: Stop, High Level
K05	Heater: Engine Coolant	T61	Daytime Running Lights
K19	Reactor System: Air Injection	UD4	Speed Alarm: 120 km/hr.
K34	Cruise Control: Electric	UL5	Radio: Delete
K60	Generator: 100 Ampere	UF2	Lamp: Cargo Area
K68	Generator: 105 Ampere	UK1	Frequencies: Japanese Radio
LB4	Engine: 4.3 Liter V6, TBI	UL2	Frequencies: European Radio
L03	Engine: 5.0 Liter V8, TBI	UL5	Radio: Delete
L05	Engine: 5.7 Liter V8, TBI	UM6	Radio Equipment: ETR AM/FM Stereo Cas-
L19	Engine: 7.4 Liter V8, TBI		sette, Clock w/Seek & Scan
L49	Engine: 6.5 Liter V8, Diesel	UM7	Radio Equipment: ETR AM/FM Stereo, Clock
L56	Engine: 6.5 Liter V8, Turbo Diesel		w/Seek & Scan
L65	Engine: 6.5 Liter V8, Turbo Diesel, HO	UP4	Radio Equipment: AM ETR
MG5	Transmission: New Venture Gear 3500	UW0	Speaker System: Dual Frt. I/P Mounted, Dual
	(5LM60), 5-Speed Manual		Roof Mounted
MM5	Transmission: Manual, 5-Speed w/Overdrive	UX1	Radio Equipment: ETR AM/FM Stereo, Seek &
MT1	Transmission: Hydra-Matic 4L80-E, 4-Speed		Scan, Cassette w/ Search and Repeat, Graphic
	Automatic		Equalizer, Digital Clock
MT8	Transmission: New Venture Gear 4500,	UY1	Camper Wiring Harness
	5-Speed Manual	UY7	Harness, Wiring: Trailer Heavy Duty (7 Wire)
MXO	Transmission: Automatic w/Overdrive	U01	Lamps, Roof Marker
M30	Transmission: Hydra-Matic 4L60-E, 4-Speed	U16	Tachometer, Engine
	Automatic	U18	Speedometer (Kilo.).
NA1	Emission System (Less than 8500 Lbs.)	U66	Radio Equipment: Four Speakers (avail. w/UM6
NA4	Emission System (Above 8500 Lbs.)		& UM7)
NA5	Emission System: Federal	U88	Radio Equipment: Six Speakers (Dual I/P
NA6	Emission System: High Altitude		Mounted, Dual Rear Side Door, Dual Roof
NB2	Emission System: California		Mounted)
ND3	Vehicle Label: Emission Control	VB3	Bumper: Chromed Rear Step
NK3	Steering Wheel: Sport	VG3	Bumper: Deluxe Front Bumper
NK7	Fuel Tank, 117 L, 31 Gal.	VK3	Bracket, License Plate: Front
NM8	Emission System: Leaded Fuel	VR4	Trailer Equipment: Weight Distributing Plat-
NRQ	Exhaust: Close Coupled		form Hitch
NY1	Shield: Fuel Tank Steel	V01	Cooling System: Radiator, Heavy Duty
NZZ	Skid Plate: Off Road	V02	Cooling System: Transmission Oil Cooler,
N33	Steering Column: Tilt		Heavy Duty
N83	Wheels: 15 X 7, Chrome, Styled	V08	Cooling System: Heavy Duty
N90	Wheels: Aluminum, Cast	V10	Cold Climate Package
OSG	Plant Code: Oshawa, ONT, GM of Canada	V22	Appearance: Deluxe Front
PF4	Wheel: 16 x 7, Aluminum, Forged	V27	Bumper Guards, Front
P01	Wheel Trim: Wheel Covers	V43	Bumper: Painted Rear Step
P06	Wheel Trim: Trim Rings	V54	Luggage Carrier: Roof, Painted
P13	Carrier, Spare Wheel, Side Mounted	V76	Towing Device: Front
P18	Carrier, Spare Tire with Hoist	XBK	Tire: Front, LT245/75R16/C BL R/PE ST TBL
QBN	Tire: All, LT245/75R16/C BW R/PE ST TBL		ALS
	OOR		
QBX	Tire: All, LT245/75R16/C WOL R/PE ST TBL		
	OOR		

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XBN	Tire: Front, LT245/75R16/C BL R/PE ST TBL OOR	YHE	Tire: Rear, LT225/75R16/C BL R/PE ST ALS
XBX	Tire: Front, LT245/75R16/C BL R/PE ST TBL OOR	YHH	Tire: Rear, LT245/75R16/E BL R/PE ST ALS
XCN	Tire: Front, P275/60R15 BW R/PE ST TL AL3 107H	YHJ	Tire: Rear, LT225/75R16/C BL R/PE ST OOR
XDE	Tire: Front, 7.50-16LT/D BL D/NY TL HWY	YHN	Tire: Rear, LT225/75R16/D BL R/PE ST TL ALS
XDL	Tire: Front, 7.50-16LT/D BL D/NY TL HWY	YHP	Tire: Rear, LT225/75R16/D BL R/PE ST TL ALS
XET	Tire: Front, P225/75R15/N BL R/PE ST TL ALS	YHR	Tire: Rear, LT225/75R16/D BL R/PE ST TL OOR
XEV	Tire: Front, P225/75R15/N RWL R/PE ST TL ALS	YTN	Tire: Rear, 225/70R19.5/F BW R/ST ST TL HWY
XFL	Tire: Front, P235/75R15/N BW R/PE ST TL ALS 105S	ZBK	Tire: Spare, LT245/75R16/C BL R/PE ST TBL OOR
XFM	Tire: Front, P235/75R15/N XNW R/PE ST TL ALS	ZBN	Tire: Spare, LT245/75R16/C BL R/PE ST TBL OOR
XFN	Tire: Front, P235/75R15/N RWL R/PE ST TL ALS	ZBX	Tire: Spare, LT245/75R16/C WOL R/PE ST TBL OOR
XGK	Tire: Front, LT245/75R16/E BL R/PE ST OOR	ZCN	Tire: Spare, P275/60R15 BW R/PE ST TL AL3 107H
XGL	Tire: Front, LT265/75R16/C BL R/PE ST OOR	ZDE	Tire: Spare, 7.50-16LT/D BL D/NY TL HWY
XGM	Tire: Front, LT265/75R16/C WOL R/PE ST OOR	ZDL	Tire: Spare, 7.50-16LT/D BL D/NY TL OOR
XHA	Tire: Front, P235/75R15/X BW R/PE ST TL ALS	ZET	Tire: Spare, P225/75R15/N BL R/PE ST TL ALS
XHB	Tire: Front, P235/75R15/X XNW R/PE ST TL ALS	ZEZ	Tire: Spare, P225/75R15/N RWL R/PE ST TL ALS
XHE	Tire: Front, LT225/75R16/C BL R/PE ST ALS	ZFL	Tire: Spare, P235/75R15/BW R/PE ST TL ALS 105S
XHH	Tire: Front, LT245/75R16/E BL R/PE ST ALS	ZFM	Tire: Spare, P235/75R15/N XNW R/PE ST TL ALS
XHJ	Tire: Front, LT225/75R16/C BL R/PE ST OOR	ZFN	Tire: Spare, P235/75R15/N XNW R/PE ST TL ALS
XHN	Tire: Front, LT225/75R16/C WOL R/PE ST OOR	ZGK	Tire: Rear, LT245/75R16/E BL R/PE ST OOR
XHP	Tire: Front, LT225/75R16/D BL R/PE ST TL ALS	ZGL	Tire: Spare, LT265/75R16/E BL R/PE ST OOR
XHR	Tire: Front, LT225/75R16/D BL R/PE ST TL OOR	ZGM	Tire: Spare, LT265/75R16/E BL R/PE ST OOR
XTN	Tire: Front, 225/70R19.5/F BW R/ST TL HWY	ZHA	Tire: Spare, P235/75R15/X BW R/PE ST TL ALS
X88	Conversion: Nameplate, Chevrolet	ZHB	Tire: Spare, P235/75R15/X XNW R/PE ST ALS
YA9	Axle: Front, 3,400 Lbs.	ZHE	Tire: Spare, LT225/75R16/C BL R/PE ST ALS
YBK	Tire: Rear, LT245/75R16/C BL R/PE ST TBL ALS	ZHH	Tire: Spare, LT245/75R16/E BL R/PE ST ALS
YBN	Tire: Rear, LT245/75R16/C BL R/PE ST TBL OOR	ZHJ	Tire: Spare, LT225/75R16/C BL R/PE ST OOR
YBX	Tire: Rear, LT245/75R16/C WOL R/PE ST TBL OOR	ZHN	Tire: Spare, LT225/75R16/C WOL R/PE ST OOR
YCN	Tire: Rear, P275/60R15 BW R/PE ST TL AL3 107H	ZHP	Tire: Spare, LT225/75R16/D BL R/PE ST TL ALS
YDE	Tire: Rear, 7.50-16LT/D BL D/NY TL HWY	ZHR	Tire: Spare, LT225/75R16/D BL R/PE ST TL OOR
YDL	Tire: Rear, 7.50-16LT/D BL D/NY TL OOR	ZQ8	Chassis Package: Sport
YD3	Axle: Base Equipment	ZTN	Tire: Spare, 225/70R19.5/F BW R/ST ST TL HWY
YD6	Spring: Rear, Base Equipment	ZW9	Body Equipment: Base Body or Chassis
YET	Tire: Rear, P225/75R15/N BL R/PE ST TL ALS	ZY1	Color Combination: Solid
YEV	Tire: Rear, P225/75R15/N RWL R/PE ST TL ALS	ZY2	Color Combination: Two-Tone
YE9	CL/SLE Equipment	ZY4	Color Combination: Deluxe Two-Tone
YFL	Tire: Rear, P235/75R15/N BW R/PE ST TL ALS 105S	Z49	Daytime Running Lights
YFM	Tire: Rear, P235/75R15/N XNW R/PE ST TL ALS	Z71	Chassis Package: Off-Road
YFN	Tire: Rear, P235/75R15/N RWL R/PE ST TL ALS	Z81	Chassis: Basic Camper Equipment
YGK	Tire: Rear, LT245/75R16/E BL R/PE ST OOR	Z82	Trailer Equipment: Heavy Duty
YGL	Tire: Rear, LT265/75R16/C BL R/PE ST OOR	01L	Secondary Color: Exterior, Special
YGM	Tire: Rear, LT265/75R16/C WOL R/PE ST OOR	01U	Primary Color: Exterior, Special
YHA	Tire: Rear, P235/75R15 XL ST ALS BL	12U	Primary Color: Exterior, Yellow White
YHB	Tire: Rear, P235/75R15/X XNW R/PE ST TL ALS	13C	Trim Combination: Cloth, Light Gray
		13D	Trim Combination: Cloth, Light Gray
		13I	Interior Trim: Light Smoke Gray
		13V	Trim Combination: Vinyl, Light Gray
		13W	Trim Combination: Vinyl, Light Gray
		15A	Stripe: Color Accent, Two Tone, Teal/Silver

19U	Primary Color: Exterior, Lamp Black	55L	Secondary Color: Exterior, Light Autumnwood Metallic
20L	Secondary Color: Exterior, Lt. Quasar Blue Metallic	55U	Primary Color: Exterior, Light Autumnwood Metallic
20U	Primary Color: Exterior, Lt. Quasar Blue Metallic	56L	Secondary Color: Exterior, Dark Autumnwood Metallic
24U	Primary Color: Exterior, Medium Blue Metallic	56U	Primary Color: Exterior, Dark Autumnwood Metallic
26A	Stripe: Color Accent, Two Tone, Blue/Silver	6Y4	Wheel and Tire: Spare, Delete
26C	Trim Combination: Cloth, Navy	60A	Stripe: Color Accent, Two Tone, Beige/Black
26D	Trim Combination: Cloth, Navy	61U	Primary Color: Exterior, Tan
26I	Interior Trim, Navy	64C	Trim Combination: Cloth, Light Beige
26V	Trim Combination: Vinyl, Navy	64D	Trim Combination: Cloth, Light Beige
26W	Trim Combination: Vinyl, Navy	64I	Interior Trim, Light Beige
27A	Stripe Color Accent: Two-Tone, Light Blue/Dark Blue	64V	Trim Combination: Vinyl, Light Beige
29U	Primary Color: Exterior, Dark Blue	64W	Trim Combination: Vinyl, Light Beige
30L	Secondary Color: Exterior, Atlantic Blue Metallic	65A	Stripe: Color Accent, Two Tone, Beige Metallic/Dark Autumnwood Metallic
30U	Primary Color: Exterior, Atlantic Blue Metallic	71A	Stripe: Color Accent, Two Tone, Silver/Red
36L	Secondary Color: Exterior, Medium Dark Teal Metallic	71U	Primary Color: Exterior, Red Orange
36U	Primary Color: Exterior, Medium Dark Teal Metallic	72U	Primary Color: Exterior, Standard Red
38L	Secondary Color: Exterior, Bright Teal Metallic	74L	Secondary Color: Exterior, Victory Red
38U	Primary Color: Exterior, Bright Teal Metallic	74U	Primary Color: Exterior, Victory Red
39A	Stripe Color Accent: Two-Tone, Light Teal Metallic/Silver	8E6	Bumper: Rear Painted
39L	Secondary Color: Exterior, Indigo Metallic	80A	Stripe: Color Accented, Two Tone, Gunmetal/Red
39U	Primary Color: Exterior, Indigo Metallic	84L	Secondary Color: Exterior, Dark Hunt Club Red Metallic
41L	Secondary Color: Exterior, Black	84U	Primary Color: Exterior, Dark Hunt Club Red Metallic
41U	Primary Color: Exterior, Black	90U	Primary Color: Exterior, Gray Metallic
46U	Primary Color: Exterior, Dark Green	91L	Secondary Color: Exterior, Dark Argent
47C	Trim Combination: Cloth, Dark Red	93A	Stripe: Color Accent, Two Tone, Gold/Red
47D	Trim Combination: Cloth, Dark Red	95L	Secondary Color: Exterior, Garnet Red Metallic
47I	Interior Trim: Dark Red	95U	Primary Color: Exterior, Garnet Red Metallic
47V	Trim Combination: Vinyl, Dark Red	96L	Secondary Color: Exterior, Ultra Silver Metallic
47W	Trim Combination: Vinyl, Dark Red	96U	Primary Color: Exterior, Ultra Silver Metallic
50L	Secondary Color: Exterior, Olympic White		
50U	Primary Color: Exterior, Blue White		
51A	Stripe: Color Accent, Two Tone, Gray/Silver		

NOTES

SECTION 0B

MAINTENANCE AND LUBRICATION

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SCHEDULED MAINTENANCE SERVICES

NORMAL VEHICLE USE

The maintenance instructions contained in the Maintenance Schedule are based on the assumption that the vehicle will be used as designed:

- To carry passengers and cargo within the limitation indicated on the vehicle certification label located on the edge of the driver's door.
- On reasonable road surfaces within legal operating limits.
- On unleaded gasoline.

MAINTENANCE SCHEDULE I

Follow Maintenance Schedule I if the vehicle is operated under one or more of the following conditions:

- When most trips are less than 6 km (4 miles).
- Operating when outside temperatures remain below freezing and when most trips are less than 16 km (10 miles).
- When most trips include extended idling and/or frequent low-speed operation as in stop-and-go traffic.
- Towing a trailer.
- Operating in dusty areas.

Maintenance Schedule I should also be followed if the vehicle is used in delivery service or other commercial applications.

MAINTENANCE SCHEDULE II

Follow Maintenance Schedule II only if none of the driving conditions specified in Maintenance Schedule I apply.

EXPLANATION OF SCHEDULED MAINTENANCE SERVICES

Refer to figures 1 through 6 for the schedules of time and/or mileage intervals. The following text gives the details of the required maintenance services.

ENGINE OIL AND ENGINE OIL FILTER CHANGE



Important

Always use "SH" quality energy conserving II oils of proper viscosity.

The "SH" designation may be shown alone or in combination with other designations such as SH/CC, SH/CD, SF, SG, CC, etc.

Oil Filter



Important

To prevent leakage of all oil filters such as PF-35, PF-51, etc., it is very important that the installation instructions listed below are closely followed.

Remove the old filter by turning counterclockwise. Clean the gasket sealing area on the engine oil filter mounting surface. (If the engine has an adapter base, make sure the threaded nipple or bolt is properly torqued.).

Figure 1—Maintenance Schedule I - Gasoline Engines with Light Duty Emissions

Item No.	If your driving conditions meet those specified in "Scheduled Maintenance Services" in this Section (or see Index), use Maintenance Schedule I (+)																					
	Service	Miles (000)	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
		Kilometers (000)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
1	Engine Oil Change*—Every 3 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Oil Filter Change*—Every 3 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2	Chassis Lubrication—Every 12 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	Clutch Fork Ball Stud Lubrication (5-speed manual transmission with deep-low only)										+											+
5	Cooling System Service *—Every 24 Months or										+											+
6	Air Cleaner Filter Replacement*\$										+											+
7	Front Wheel Bearing Repack							+			+					+						+
8	Transmission Service **																					
10	Fuel Filter Replacement*\$										+											+
11	Spark Plugs Replacement*										+											+
12	Spark Plug Wire Inspection*																					+
15	Engine Timing Check*\$																					+
16	Fuel Tank, Cap and Lines Inspection *\$																					+
18	Engine Accessory Drive (Serpentine) Belt Inspection*																					+
24	Tire and Wheel Rotation**			+					+				+						+			
25	Drive Axle Service**		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
26	Brake Systems Inspection**																					

* An Emission Control Service

** See "Explanation of Scheduled Maintenance Services" in the Index

\$ The California Air Resources Board has determined that the failure to perform this maintenance item will not nullify the emission warranty or limit recall liability prior to the completion of vehicle useful life. General Motors, however, urges that all recommended maintenance services be performed at the indicated intervals and the maintenance be recorded.

T0401/T0901

THE SERVICES SHOWN ON THIS CHART UP TO 60,000 MILES (100 000 km) ARE TO BE DONE AFTER 60,000 MILES AT THE SAME INTERVALS.

T0402/T0902

3100r5284

Item No.	If your driving conditions meet those specified in "Scheduled Maintenance Services" in this Section (or see Index), use Maintenance Schedule I (+)									
	Service	Miles (000)	7.5	15	22.5	30	37.5	45	52.5	60
		Kilometers (000)	12.5	25	37.5	50	62.5	75	87.5	100
1	Engine Oil Change*—Every 12 Months, or		•	•	•	•	•	•	•	•
	Oil Filter Change*—Every 12 Months, or		•		•		•		•	
2	Chassis Lubrication—Every 12 Months, or		•	•	•	•	•	•	•	•
3	Clutch Fork Ball Stud Lubrication					•				•
5	Cooling System Service*—Every 24 Months or					•				•
6	Air Cleaner Filter Replacement*					•				•
7	Front Wheel Bearing Repack					•				•
8	Transmission Service **									
10	Fuel Filter Replacement*\$									•
11	Spark Plugs Replacement*					•				•
12	Spark Plug Wire Inspection*									•
15	Engine Timing Check*\$									•
16	Fuel Tank, Cap and Lines Inspection*\$									•
18	Engine Accessory Drive (Serpentine) Belt Inspection*									•
24	Tire and Wheel Rotation**		•		•		•		•	
25	Drive Axle Service**		•	•	•	•	•	•	•	•
26	Brake Systems Inspection**									

* An Emission Control Service

** See "Explanation of Scheduled Maintenance Services" in the Index

\$ The California Air Resources Board has determined that the failure to perform this maintenance item will not nullify the emission warranty or limit recall liability prior to the completion of vehicle useful life. General Motors, however, urges that all recommended maintenance services be performed at the indicated intervals and the maintenance be recorded.

THE SERVICES SHOWN ON THIS CHART UP TO 60,000 MILES (100 000 km) ARE TO BE DONE AFTER 60,000 MILES AT THE SAME INTERVALS.

T0403/T0903

3100r528t

Figure 2—Maintenance Schedule II - Gasoline Engines with Light Duty Emissions

Item No.	Service	If your driving conditions meet those specified in "Scheduled Maintenance Services" in this Section (or see Index), use Maintenance Schedule I (+)																						
		Miles (000)	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60		
		Kilometers (000)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100		
1	Engine Oil Change*—Every 3 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Oil Filter Change*—Every 3 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2	Chassis Lubrication—Every 12 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	Clutch Fork Ball Stud Lubrication											+												+
5	Cooling System Service*—Every 24 Months or									+								+						
6	Air Cleaner Filter Replacement*									+								+						
7	Front Wheel Bearing Repack						+							+				+						
8	Transmission Service**																							
10	Fuel Filter Replacement*						+			+								+					+	
11	Spark Plug Replacement*										+									+				
12	Spark Plug Wire Inspection*																					+		
13	EGR System Inspection*																					+		
14	Electronic Vacuum Regulator Valve (EVRV) Inspection*																					+		
15	Engine Timing Check▲*									+								+						
16	Fuel Tank, Cap and Lines Inspection*																					+		
17	Thermostatically Controlled Air Cleaner Inspection▲*									+								+						
18	Engine Accessory Drive (Serpentine) Belt Inspection*						+			+				+				+					+	
19	Evaporative Control System Inspection*																					+		
20	Shields and Underhood Insulation Inspection▲■						+			+				+				+				+		
21	Air Intake System Inspection▲■									+								+						
22	Thermostatically Controlled Engine Cooling Fan Check▲■—Every 12 Months or						+			+				+				+				+		
24	Tire and Wheel Rotation**			+										+					+					
25	Drive Axle Service**		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
26	Brake Systems Inspection**																							

* An Emission Control Service

** See "Explanation of Scheduled Maintenance Services" in this section.

▲ Also a Noise Emission Control Service

■ Applicable only to vehicles sold in the United States

T0404

THE SERVICES SHOWN ON THIS CHART UP TO 60,000 MILES (100 000 km) ARE TO BE DONE AFTER 60,000 MILES AT THE SAME INTERVALS.

T0405

Figure 3—Maintenance Schedule I - Gasoline Engines with Heavy Duty Emissions

3100/5286

Figure 4—Maintenance Schedule II - Gasoline Engines with Heavy Duty Emissions

Item No.	If your driving conditions meet those specified in "Scheduled Maintenance Services" in this Section (or see Index), use Maintenance Schedule I (+)																					
	Service	Miles (000)	3	6	9	12	15	18														
		Kilometers (000)	5	10	15	20	25	30	21	24	27	30	33	36	39	42	45	48	51	54	57	60
									21	24	27	30	33	36	39	42	45	48	51	54	57	60
									35	40	45	50	55	60	65	70	75	80	85	90	95	100
1	Engine Oil Change*—Every 12 Months, or		•			•		•		•			•		•		•		•			•
	Oil Filter Change*—Every 12 Months, or		•					•				•				•				•		
2	Chassis Lubrication—Every 12 Months, or		•			•		•		•			•		•		•		•			•
3	Clutch Fork Bell Stud Lubrication										•											•
5	Cooling System Service *—Every 24 Months or									•								•				
6	Air Cleaner Filter Replacement*									•								•				
7	Front Wheel Bearing Repack									•								•				
8	Transmission Service**																					
10	Fuel Filter Replacement*									•								•				
11	Spark Plugs Replacement*										•									•		
12	Spark Plug Wire Inspection*																					•
13	EGR System Inspection*																					•
14	Electronic Vacuum Regulator Valve (EVRV) Inspection*																					•
15	Engine Timing Check▲*									•								•				
16	Fuel Tank, Cap and Lines Inspection *																					•
17	Thermostatically Controlled Air Cleaner Inspection▲*									•								•				
18	Engine Accessory Drive (Serpentine) Belt Inspection*						•			•				•				•				•
19	Evaporative Control System Inspection*																					•
20	Shields and Underhood Insulation Inspection▲■						•			•				•				•				•
21	Air Intake System Inspection▲■									•								•				
22	Thermostatically Controlled Engine Cooling Fan Check▲■—Every 12 Months or						•			•				•				•				•
24	Tire and Wheel Rotation**		•					•			•					•				•		
25	Drive Axle Service**		•			•		•		•			•		•		•		•			•
26	Brake Systems Inspection**																					

* An Emission Control Service

** See "Explanation of Scheduled Maintenance Services" in this section.

▲ Also a Noise Emission Control Service

■ Applicable only to vehicles sold in the United States

T0406

THE SERVICES SHOWN ON THIS CHART UP TO 60,000 MILES (100 000 km) ARE TO BE DONE AFTER 60,000 MILES AT THE SAME INTERVALS.

T0407

3100r5287

Item No.	If your driving conditions meet those specified in "Scheduled Maintenance Services" in this section, use Maintenance Schedule I (+).																									
	Service	Miles (000)	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	40	42.5	45	47.5	50	52.5	55	57.5	60
		Kilometers (000)	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	100
1	Engine Oil Change*—Every 3 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Oil Filter Change*—Every 3 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2	Chassis Lubrication—Every 12 Months, or		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	Clutch Fork Ball Stud Lubrication													+												+
4	Engine Idle Speed Adjustment*			+										+												+
5	Cooling System Service*—Every 24 Months or													+												+
6	Air Cleaner Filter Replacement*★																									
7	Front Wheel Bearing Repack							+												+						+
8	Transmission Service**																									
9	CDRV System Inspection*																									+
10	Fuel Filter Replacement*													+												+
13	EGR System Inspection*																									+
18	Engine Accessory Drive (Serpentine) Belt Inspection*																									+
20	Shields and Underhood Insulation Inspection▲■					+				+				+				+				+				+
21	Air Intake System Inspection▲■					+				+				+				+				+				+
22	Thermostatically Controlled Engine Cooling Fan Check▲■—Every 12 Months or					+				+				+				+				+				+
23	Exhaust Pressure Regulator Valve Inspection*																									+
24	Tire and Wheel Rotation**			+							+					+							+			
25	Drive Axle Service**			+		+		+		+			+		+		+		+		+		+		+	+
26	Brake Systems Inspection**																									

★ Change filter every 15,000 miles (24 000 km), except when operating in dusty conditions. Dusty conditions may require more frequent filter replacement. Extreme dust and dirt operating conditions (off-road), may require the air filter to be checked as often as every 300 miles (483 km) and replaced as necessary.

* An Emission Control Service

** See "Explanation of Scheduled Maintenance Services" in this section.

▲ Also a Noise Emission Control Service

■ Applicable only to trucks sold in the United States

T0408/T0908

THE SERVICES SHOWN ON THIS CHART UP TO 60,000 MILES (100 000 km) ARE TO BE DONE AFTER 60,000 MILES AT THE SAME INTERVALS.

T0409/T0909

Figure 5—Maintenance Schedule I - Diesel Engines

3100r5288

Item No.	If your driving conditions meet those specified in "Scheduled Maintenance Services" in this section, use Maintenance Schedule I (+).																									
	Service	Miles (000)	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	40	42.5	45	47.5	50	52.5	55	57.5	60
		Kilometers (000)	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	100
1	Engine Oil Change*—Every 12 Months, or		•		•		•		•		•		•		•		•		•		•		•		•	
	Oil Filter Change*—Every 12 Months, or		•		•		•		•		•		•		•		•		•		•		•		•	
2	Chassis Lubrication—Every 12 Months, or		•		•		•		•		•		•		•		•		•		•		•		•	
3	Clutch Fork Ball Stud Lubrication												•													•
4	Engine Idle Speed Adjustment*		•										•													•
5	Cooling System Service *—Every 24 Months or												•													•
6	Air Cleaner Filter Replacement* ★												•													•
7	Front Wheel Bearing Repack												•													•
8	Transmission Service**																									
9	CDRV System Inspection*																									•
10	Fuel Filter Replacement*												•													•
13	EGR System Inspection*																									•
18	Engine Accessory Drive (Serpentine) Belt Inspection*																									•
20	Shields and Underhood Insulation Inspection▲■					•				•			•				•				•					•
21	Air Intake System Inspection▲■					•				•			•				•				•					•
22	Thermostatically Controlled Engine Cooling Fan Check▲■—Every 12 Months or					•				•			•				•				•					•
23	Exhaust Pressure Regulator Valve Inspection*																									•
24	Tire and Wheel Rotation**		•					•			•				•				•				•			
25	Drive Axle Service**		•		•		•		•		•		•		•		•		•		•		•		•	
26	Brake Systems Inspection**																									

* An Emission Control Service

** See "Explanation of Scheduled Maintenance Services" in this section.

▲ Also a Noise Emission Control Service (applicable to vehicles with engine VIN code Y).

■ Applicable only to trucks sold in the United States

T0410/T0910

THE SERVICES SHOWN ON THIS CHART UP TO 60,000 MILES (100 000 km) ARE TO BE DONE AFTER 60,000 MILES AT THE SAME INTERVALS.

T0411/T0911

Figure 6—Maintenance Schedule II - Diesel Engines

3100r5289

OB-8 MAINTENANCE AND LUBRICATION

Lightly oil gasket with clean oil, and install filter. After the oil filter gasket contacts the oil filter mounting surface, tighten 3/4 to 1 full turn. When necessary, use a cap-type wrench, strap-type wrench with handle, or equivalent to ensure proper installation.

With engine oil at the proper level, run the engine 3 minutes and thoroughly check the filter area for leaks.

Engine Oil Viscosity

Engine oil viscosity (thickness) has an effect on fuel economy and cold-weather operation (starting and oil flow). Lower viscosity engine oils can provide better fuel economy and cold weather performance; however, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication.

NOTICE: *Using oils of any viscosity other than those viscosities recommended could result in engine damage.*

When choosing an oil, consider the range of temperatures the vehicle will be operated in before the next oil change.

OTHER REQUIRED SERVICES EACH TIME OIL IS CHANGED

1. **Automatic Transmission Fluid Level**--Maintain fluid level within operating range on the oil level indicator. Refer to "Approximate Fluid Capacities."
2. **Manual Transmission Fluid Level**--Check fluid level and add as required. Refer to "Approximate Fluid Capacities."
3. **Engine Coolant Level and Condition**--Check the coolant level in the coolant reservoir and add if necessary. If an overheating condition has occurred, check the coolant level in the radiator after the engine has cooled. Inspect the coolant and replace if it is dirty or rusty.
4. **Brake Systems Inspection**--Inspect lines and hoses for proper hookup, binding, leaks, cracks, chafing, etc. For convenience, the following should be done when the wheels are removed for rotation: Inspect the disc brake pads for wear and rotors for surface condition. Inspect the drum brake linings for wear and cracks. Inspect other brake parts, including drums, wheel cylinders, parking brake, etc., at the same time. Check the parking brake adjustment. Inspect the brakes more often if habit or conditions result in frequent braking.
5. **Tire Inflation Pressure Check**--Check the tires for proper inflation.
6. **Drive Axle Service**--Check front/rear axle fluid level and add as needed. Check constant velocity joints and axle seals for leaking.
 - On vehicles with a locking differential—Drain fluid at first oil change and refill. Check fluid level and add as needed at subsequent oil changes. In dusty areas or trailer towing applications, drain fluid at every 24,135 km (15,000 miles) and refill.
 - On vehicles with a standard differential—Check fluid level and add as needed at every oil change. In dusty areas or trailer towing applications, drain fluid every 24,135 km (15,000 miles) and refill.
 - More frequent lubrication may be required for heavy-duty or off-road use.
 - On 3500 H.D. models with applications requiring extreme overload/trailer tow conditions and high speed conditions (above 72 km/h (45 mph) for extended periods of time—Change lubrication every 4,828 km (3,000 miles) or 3 months, whichever comes first, or use 75W-140 synthetic lubrication.
7. **Windshield Washer Fluid Level**--Check the level in the reservoir and add if necessary.
8. **Hood Latch Operation**--When opening the hood, note the operation of the secondary latch. It should keep the hood from opening all the way when the primary latch is released. Make sure the hood closes firmly.
9. **Lamp Operation**--Check the operation of the license plate lamp, side marker lamps, headlamps and high beams, parking lamps, tail lamps, brake lamps, turn signals, backup lamps, and hazard warning flasher.
10. **Power Steering System Reservoir Level**--Check and keep at proper level as described in SECTION 3B1.
11. **Brake Master Cylinder Reservoir Level**--Check the fluid as described in SECTION 5A and keep it at the proper level. A low fluid level can indicate a leak or worn disc pads that may need service.
12. **Transfer Case (Four Wheel Drive) Inspection**--Every 12 months or at oil change intervals, check front axle and transfer case and add lubricant when necessary. Oil the control lever pivot point and all exposed control linkage. Check the vent hose at the transfer case for kinks and proper installation. More frequent lubrication may be required on heavy-duty or off-road use.

CHASSIS LUBRICATION

Lubricate the front suspension, king pin bushings, steering linkage, transmission and transfer case shift linkage, parking brake cable guides, rear driveline center splines and front axle propshaft splines, brake pedal springs, and clutch pedal spring at the intervals specified (figures 7, 8, 9, and 10).

If you have a 3500 HD, lubricate the king pins and bushings every 2,500 km (1,500 miles) for Schedule I, or every 5,000 km (3,000 miles) for Schedule II.

Ball joints and king pin bushings should not be lubricated unless their temperature is -12° C (10° F) or higher. During cold weather, the ball joint should be allowed to warm up as necessary before being lubricated. Use a low-pressure grease gun on all joints to prevent seal damage.

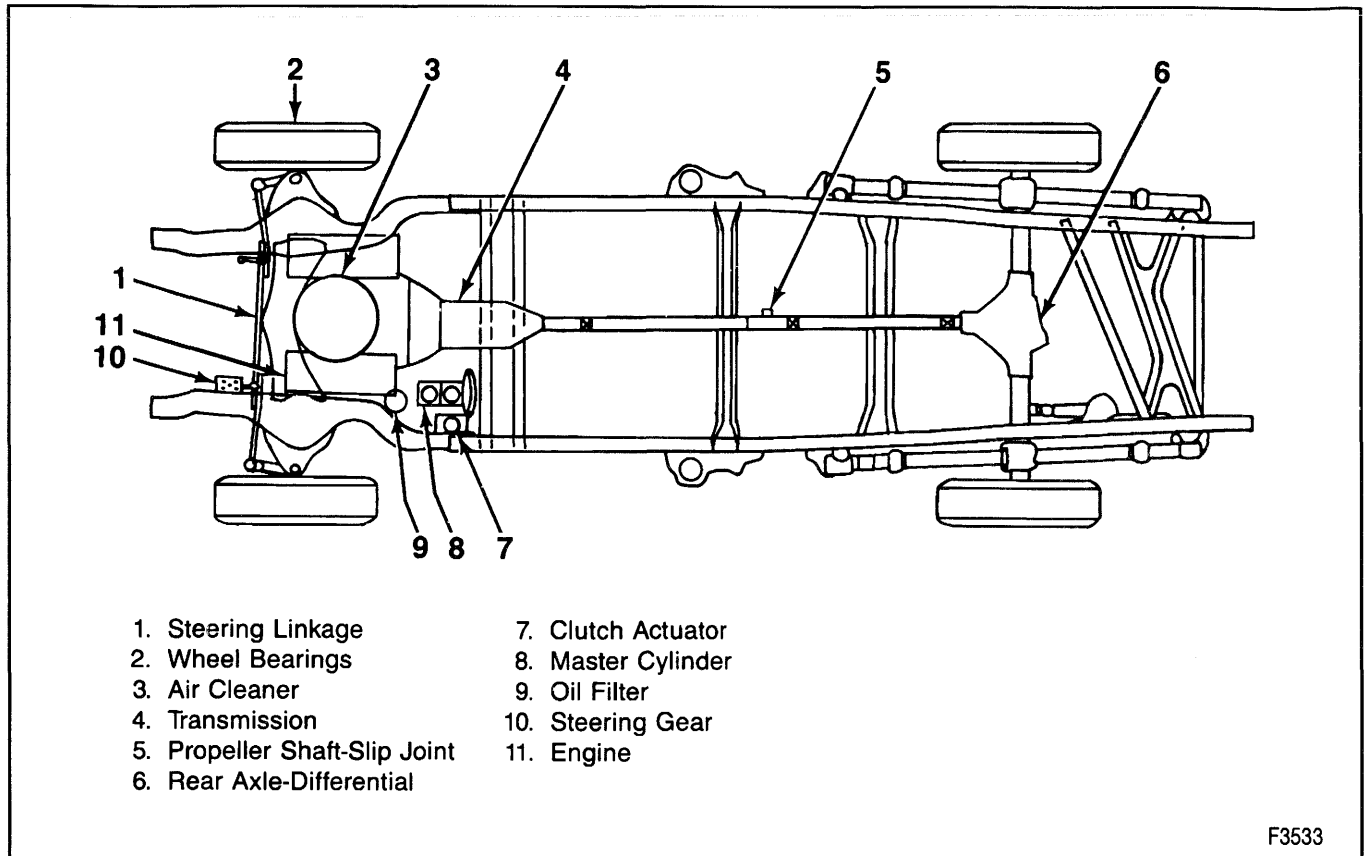


Figure 7—Lubrication Points (Two-Wheel Drive Models)

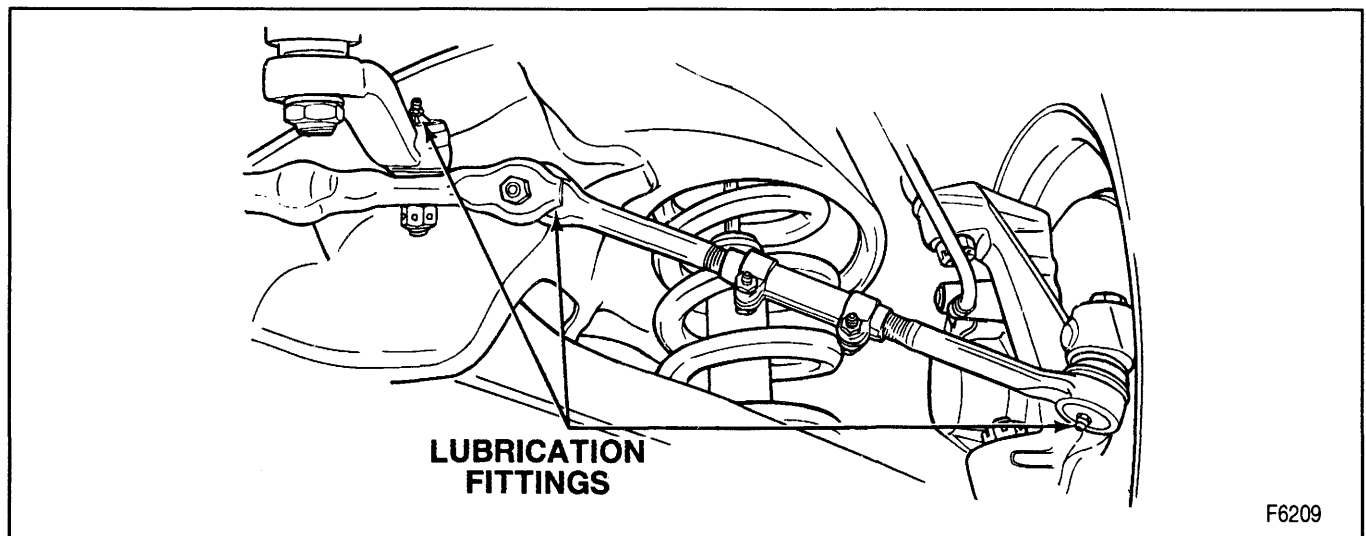


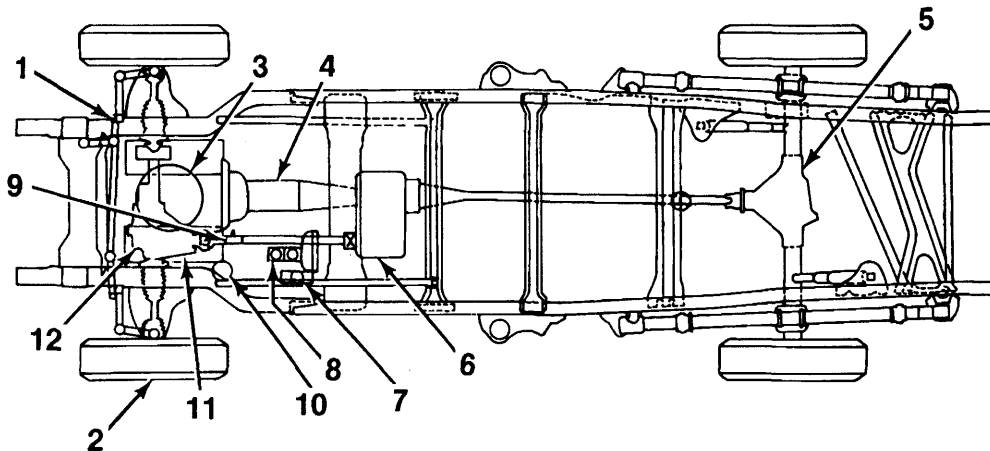
Figure 8—Lubrication Fittings (Driver Side)

SERVICES TO BE PERFORMED AT LEAST TWICE A YEAR

1. **Weatherstrip Lubrication**--Apply silicone grease. Apply a thin film using a clean cloth.
2. **Steering and Suspension Inspection**--Inspect the front and rear suspension and steering systems for damaged, loose or missing parts, signs of wear, or lack of lubrication. Inspect power steering lines and hoses for proper hookup, binding, leaks, cracks,

chafing, etc. Clean and inspect the front drive axle boot seals for damage, tears, or leakage and replace as necessary.

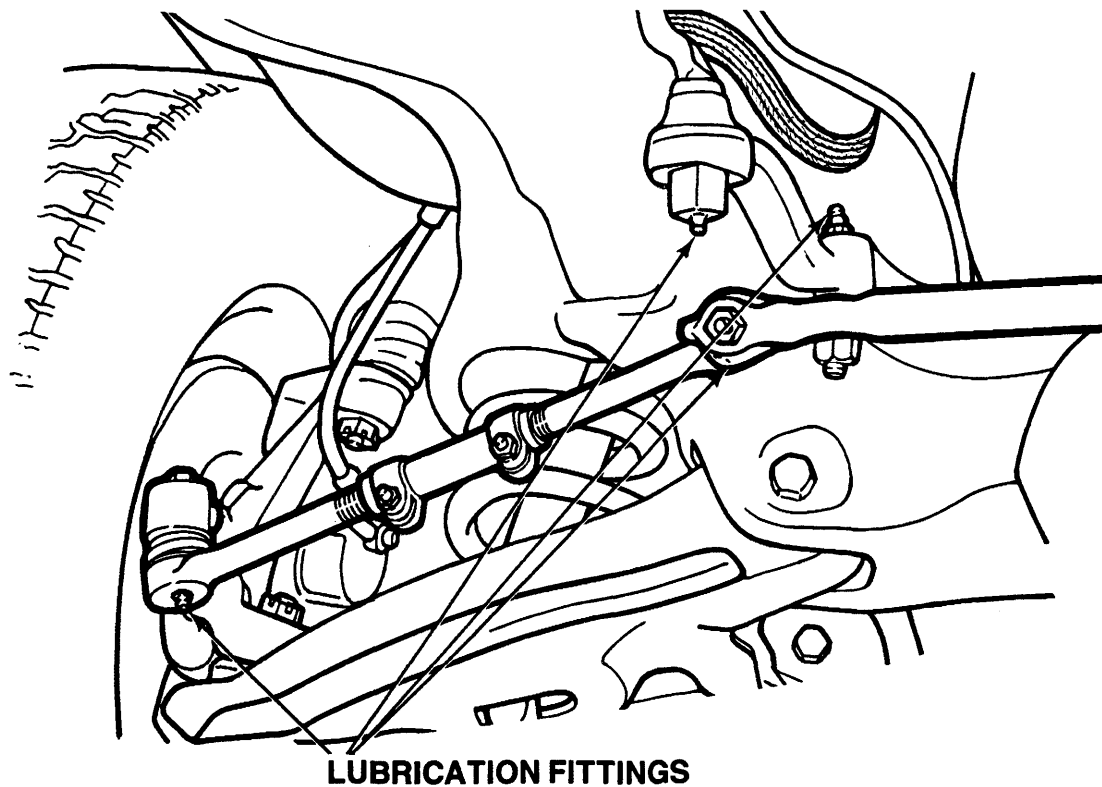
3. **Exhaust System Inspection**--Inspect the complete system including the three-way catalytic converter. Inspect the body near the exhaust system. Look for broken, damaged, missing, or out-of-position parts as well as open seams, holes, loose connections, or other conditions that could cause a heat buildup in the floor pan or let exhaust fumes seep into the passenger compartment.



1. Steering Linkage
2. Wheel Bearings
3. Air Cleaner
4. Transmission
5. Rear Axle – Differential
6. Transfer Case
7. Clutch Actuator
8. Brake Master Cylinder
9. Front Propeller Shaft
10. Oil Filter
11. Engine
12. Front Axle – Differential

F3534

Figure 9—Lubrication Points (Four-Wheel Drive Models)



F6210

Figure 10—Lubrication Fittings (Passenger Side)

4. **Throttle Linkage Inspection**--Lubricate all pivot points with engine oil, except the TBI throttle shaft. Do not oil any accelerator or cruise control cables. Replace any cables that have high effort or excessive wear.
5. **Drive Axle Inspection**--Check front/rear axle fluid level and add as needed. Check constant velocity joints and axle seals for leaking.

SERVICES TO BE PERFORMED AT LEAST ANNUALLY

1. **Parking Brake and Transmission "Park" Mechanism Operation**--Before checking the holding ability of the parking brake and automatic transmission "Park" mechanism, park on a fairly steep hill with enough room for movement in the downhill direction.

- To check the parking brake: With the engine running and the transmission in "N" (Neutral), slowly remove foot pressure from the regular brake pedal. Do this until the vehicle is held by the parking brake only.
- To check the "P" (Park) mechanism holding ability: Apply the regular brake and shift to "P" (Park). Release the manual parking brake, then slowly release the regular brake.

CAUTION: To reduce the risk of personal injury or property damage, be prepared to apply the regular brakes promptly if the vehicle begins to move.

2. **Transmission Neutral or Clutch Start Switch Operation**

- Before you start, be sure you have enough room around the vehicle.
- Firmly apply both the manual parking brake and the regular brake. Do not use the accelerator pedal.
- Be ready to turn off the engine immediately if it starts.
- On automatic transmission vehicles, try to start the engine in each gear. The starter should crank only in the "P" (Park) or "N" (Neutral) positions.
- On manual transmission vehicles, put the shift lever in "N" (Neutral), push the clutch down halfway, and try to start the engine. The starter should work only when the clutch is pushed down all the way to the floor.

CAUTION: Before performing the above transmission neutral starter switch check, be sure to have enough room around the vehicle. Then, firmly apply the parking brake and regular brakes. Do not use the accelerator pedal. If the engine starts, be ready to turn off the ignition promptly. Take these precautions because the vehicle could move without warning and possibly cause personal injury or property damage.

3. **Steering Column Lock Operation**--While parked, try to turn the key to "Lock" in each gear range.

- With a automatic transmission, the key should turn to "Lock" only when the gear shift is in "P" (Park).
- With a manual transmission, the key should turn to "Lock" only when the gear shift is in "R" (Reverse).

On vehicles with a key release lever, try to turn the key to "Lock" without depressing the lever. The key should turn to "Lock" only with the key lever depressed. On all vehicles, the key should come out only in "Lock."

4. **Lap and Shoulder Belt Condition and Operation**--Inspect the seatbelt system, including webbing, buckles, latch plates, retractor, guide loops, and anchors. Have a belt assembly replaced if the webbing has been cut or otherwise damaged.
5. **Seatback Recliner Operation (If Equipped)**--Make sure the recliner is holding by pushing and pulling on the top of the seat back while it is reclined.
6. **Spare Tire and Jack Storage**--Be alert to rattles in the rear of the vehicle. Make sure the spare tire, all jacking equipment, any tire inflator, and any covers or doors are securely stowed at all times. Oil the jack ratchet or screw mechanism after each use.
7. **Key Lock Service**--Lubricate all key lock cylinders.
8. **Body Lubrication Service**--Lubricate all body door hinges, including the endgate, endgate handle pivot points, and endgate mounted spare tire carrier (if equipped), lubricate the body hood, fuel door, and rear compartment hinges, latches, and locks including interior glove box and console doors, and any moving seat hardware. Lubricate the hood safety lever pivot and prop rod pivot. More frequent lubrication may be required when exposed to a corrosive environment.
9. **Cooling System Service**--Drain, flush, and refill the system with new coolant. Inspect the hoses and replace them if they are cracked, swollen, or deteriorated. Tighten all hose clamps (except constant tension clamps). Remove debris and clean the outside of the radiator and air conditioning condenser (if equipped). Wash the radiator neck. To ensure proper operation, pressure test the radiator and cap.
10. **Transfer Case Service**--Check the transfer case fluid level. Check the vent hose at the transfer case for kinks and proper installation. More frequent lubrication may be required in heavy or frequent trailer towing applications. A fluid loss may indicate a problem. Have it inspected and repaired at once.

CONTINUATION OF SCHEDULED MAINTENANCE SERVICES

1. **Tire and Wheel Inspection and Rotation**--For proper wear and maximum tire life, rotate tires at the first 10,000 km (6,000 miles) for Schedule I or 12,500 km (7,500 miles) for Schedule II and then every 25,000 km (15,000 miles) thereafter. Check the tires for uneven wear or damage. If irregular or premature wear exists, check the wheel alignment. Also, check for damaged wheels. For dual rear

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wheels, whenever the vehicle, wheels, or fasteners are new; have the wheel fastener torque set at the first 160, 1,600, and 10,000 km (100, 1,000 and 6,000 miles).

For 3500 HD models, block the tires opposite those being removed to keep the vehicle from moving.

2. **Engine Accessory Drive Belt Inspection**--Inspect belts. Look for cracks, fraying, wear, and proper tension. Replace as needed. Refer to SECTION 6B1.
3. **Transmission Service**--On vehicles with a automatic transmission, change the transmission fluid and filter every 25,000 km (15,000 miles) for vehicles under 8,600 GVWR or every 20,000 km (12,000 miles) for vehicles over 8,600 GVWR if the vehicle is mainly driven under one or more of these conditions:
 - In heavy city traffic, where the outside temperature regularly reaches above 32° C (90° F) or higher.
 - Hilly or mountainous terrain.
 - Frequent trailer towing.
 - Uses such as found in taxi, police car, or delivery service.If the vehicle is not used mainly under any of these conditions, change the fluid and filter every 50,000 km (30,000 miles) for vehicles under 8,600 GVWR or every 40,000 km (24,000 mile) for vehicles over 8,600 GVWR.
- On vehicles with a manual transmission, the transmission fluid does not require periodic changing.
4. **Spark Plug Replacement**--Replace the spark plugs with the type listed in this section. Refer to "Maintenance Items."
5. **Spark Plug Wire Inspection**--Clean wires and inspect for burns, cracks, or other damage. Check the wire boot fit at the distributor and at the spark plugs. Replace wires as needed.
6. **EGR System Service**--Perform "EGR System Check." Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.
7. **Air Cleaner Filter Replacement**--Replace the air cleaner filter every 50,000 km (30,000 miles) or more often under dirty conditions.
8. **Engine Timing Check**--Adjust the timing to underhood label specifications. Inspect the inside and outside of the distributor cap and rotor for cracks, carbon tracking, and corrosion. Clean and replace as needed.
9. **Fuel Tank, Cap, and Lines Inspection**--Inspect the fuel tank, cap, and lines (including fuel rails and injection assembly) for damage or leaks. Inspect the fuel cap gasket for an even filler neck imprint or any damage. Replace parts as needed.
10. **PCV System Inspection**--Check that the PCV (Positive Crankcase Ventilation) system works properly. Replace the valve and any worn, plugged, or collapsed hoses as necessary.

11. **Fuel Filter Replacement**--Replace the fuel filter at the specified interval or sooner if clogged.
12. **Front Wheel Bearing Repack (2WD Only)**--Clean and repack the front wheel bearings at each brake relining, or at the specified interval, whichever comes first.
13. **Clutch Fork Ball Stud Lubrication**--Lubricate the clutch fork ball stud through the fitting on the clutch housing. Lubricant must be added sparingly to the fitting, as only 0.0066 lb. (0.003 kg) is required to lubricate the ball stud surface. Do not add lubricant more often than required as clutch damage may occur (5-Speed w/Low Gear Models Only).
14. **Transfer Case Fluid Change**--In heavy or frequent trailer towing applications, drain the fluid and refill every 50,000 km (30,000 miles).
15. **Engine Idle Speed Adjustment (6.5L VIN Y Diesel Engines)**--Adjust to the specifications shown on the underhood label. You must use calibrated test equipment.
16. **CDRV System Inspection**--Check the Crankcase Depression Regulator Valve System for any worn, plugged or collapsed hoses.
17. **Electronic Vacuum Regulator Valve (EVRV) Inspection**--Inspect filter for excessive contamination or plugging. If required, clean element with a solution of biodegradable soap and water, let dry and reinstall element.
18. **Evaporative Control System (ECS) Inspection**--Check all fuel and vapor lines and hoses for proper hookup, routing, and condition. Check that the purge valve operates properly, if equipped. Replace as needed.
19. **Shields and Underhood Inspection**--Inspect shields and underhood insulation for damage or looseness. Adjust or replace as required.
20. **Air Intake System Inspection**--Check the air intake system to see that the gaskets are seated properly and all hose connections, fasteners, and other components are tight. Also, check to be sure that the air cleaner housing is properly seated, the cover fits tightly, and the wingnut is tight. Tighten connections and fasteners or replace damaged parts as required.
21. **Thermostatically Controlled Air Cleaner Inspection (If Equipped)**--Inspect all hoses and ducts for proper hookup. Make sure valve works properly.
22. **Exhaust Pressure Regulator Valve Inspection**--Check that the valve works properly. Correct any binding. Inspect hoses for cracks, chafing, and decay. Replace parts as needed.
23. **Accelerator Cable Replacement**--Replace the accelerator cable on all gasoline equipped engines at 160,000 km (100,00 miles). The 6.5L diesel engines used on this vehicle are equipped with an electronic accelerator, so cable replacement is not required.

RECOMMENDED FLUIDS AND LUBRICANTS

Engine Oil—GM Goodwrench motor oil or equivalent for API Service SG or SG/CE of the recommended viscosity.

Engine Coolant—Mixture of water and a good quality ethylene glycol base antifreeze conforming to GM Specification 6038M, (GM P/N 1052103) or equivalent.

Hydraulic Clutch System—Hydraulic clutch fluid (GM P/N 12345347) or equivalent DOT-3 brake fluid.

Hydraulic Brake System—Delco Supreme II (GM P/N 1052535) or equivalent DOT-3 brake fluid.

Parking Brake Cables—Chassis grease meeting requirements of NLGI Grade 2, Category LB or GC-LB (GM P/N 1052497) or equivalent.

Power Steering System—Power steering fluid meeting requirements of GM specification 9985010, (GM P/N 1050017) or equivalent.

Automatic Transmission—DEXRON® III or II-E automatic transmission fluid.

Key Lock Cylinders—Lubricate with Multi-Purpose Lubricant, (GM P/N 12345120) or equivalent or synthetic SAE 5W30 engine oil.

Differential (Standard Front and Rear Axle)—SAE 80-W-90 GL-5 gear lubricant (GM P/N 1052271).

Differential (Locking)—SAE 80-W-90 gear lubricant (GM P/N 1052271).

Clutch Fork Ball Stud—Chassis grease meeting requirements of NLGI Grade 2, Category LB or GC-LB (GM P/N 1052497).

Front Wheel Bearings—Chassis grease meeting requirements of NLGI Grade 2, Category LB or GC-LB (GM P/N 1052497).

Chassis Lubrication—Chassis grease meeting requirements of GM 6031-M (GM P/N 1052497).

Weatherstrips—Silicone grease (GM P/N 1052863) or equivalent.

Windshield Washer Solvent—GM Optikleen washer solvent (GM P/N 1051515) or equivalent.

Hood Latch Pivots and Spring Anchor—Engine oil.

Hood Latch Release Pawl—Chassis grease meeting requirements of GM specification 6031M (GM P/N 1052497).

Automatic Transmission Shift Linkage, Floor Shift Linkage, Hood and Door Hinges, and Body Door Hinge Pins—Engine oil.

Manual Transmission:

- A. 5-Speed (RPO MT8)**—Castrol Syntorq or equivalent (GM P/N 12345871).
- B. 5-Speed (RPO MG5)**—Standard transmission fluid (GM P/N 12345349).

Transfer Case—DEXRON® IIE automatic transmission fluid (GM P/N 12345881).

Transfer Case Shift Lever, Propeller Shaft—Chassis grease meeting requirements of NLGI Grade 2, Category LB or GC-LB (GM P/N 1052497).

Constant Velocity Universal Joint—Chassis grease meeting requirements of GM 6031-M (GM P/N 1052497).

Key Lock Cylinders—GM Multi-Purpose lubricant (GM P/N 12345120) or a synthetic light weight engine oil (SAE 5W-30).

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MAINTENANCE ITEMS

Air Cleaner Element

4.3L (VIN Z).....	AC Type A-178CW
5.0L (VIN H).....	AC Type A-348C
5.7L (VIN K).....	AC Type A-348C
6.5L (VIN F, P, and S).....	AC Type A-917C
7.4L (VIN N).....	AC Type A-348C

Engine Oil Filter

4.3L (VIN Z).....	AC Type PF-51
5.0L (VIN H)*	AC Type PF-35
5.7L (VIN K)*	AC Type PF-35
6.5L (VIN F, P, and S).....	AC Type PF-35
7.4L (VIN N).....	AC Type PF-35

*Four-wheel drive vehicles use a PF-51 oil filter.

PCV Valve

4.3L (VIN Z).....	AC Type CV-789C
5.0L (H), 5.7L (K), 7.4L (N)	AC Type CV-774C

Spark Plugs and Gap

4.3L (VIN Z).....	AC Type CR43TS (90 mm, .035")
5.0L (VIN H).....	AC Type CR43TS (90 mm, .035")
5.7L (VIN K).....	AC Type CR43TS (90 mm, .035")
7.4L (VIN N).....	AC Type CR43TS (90 mm, .035")

Fuel Filter

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4.3L (VIN Z).....	AC Type GF-481
5.0L (VIN H).....	AC Type GF-481
5.7L (VIN K).....	AC Type GF-481
6.5L (VIN F, P, and S).....	AC Type TP-1006
7.4L (VIN N).....	AC Type GF-481
Radiator Cap	
4.3L (VIN Z).....	AC Type RC-36
5.0L (VIN H).....	AC Type RC-36
5.7L (VIN K).....	AC Type RC-36
6.5L (VIN F, P, and S).....	AC Type RC-32
7.4L (VIN N).....	AC Type RC-32

APPROXIMATE FLUID CAPACITIES

Engine Cooling System

4.3L (VIN Z)	
With Air Conditioning.....	10.3 L (11 qts.)
Without Air Conditioning.....	10.3 L (11 qts.)
5.0L (VIN H)	
With Air Conditioning.....	17.0 L (18 qts.)
Without Air Conditioning.....	16.5 L (17.5 qts.)
5.7L (VIN K)	
With Air Conditioning.....	17.0 L (18 qts.)
Without Air Conditioning.....	16.5 L (17.5 qts.)
With Air Conditioning—3500 H.D.....	25.5 L (27 qts.)
Without Air Conditioning—3500 H.D.....	25.0 L (26.5 qts.)
6.5L (VIN F, P, and S)	
With Air Conditioning.....	25.0 L (26.5 qts.)
Without Air Conditioning.....	25.0 L (26.5 qts.)
7.4L (VIN N)	
With Air Conditioning.....	23.5 L (25 qts.)
Without Air Conditioning.....	22.0 L (23 qts.)
With Air Conditioning—3500 H.D.....	27.0 L (28.5 qts.)
Without Air Conditioning—C3500 H.D.....	25.0 L (26.5 qts.)

Engine Crankcase

4.3L (VIN Z)	
With Filter.....	4.3 L (4.5 qts.)
Without Filter.....	3.8 L (4.0 qts.)
5.0L (VIN H)	
With Filter.....	4.8 L (5.0 qts.)
Without Filter.....	3.8 L (4.0 qts.)
5.7L (VIN K)**	
With Filter.....	4.8 L (5.0 qts.)
Without Filter.....	3.8 L (4.0 qts.)
6.5L (VIN F, P, and S)*	
With Filter.....	6.5 L (7.0 qts.)
7.4L (VIN N)**	
With Filter.....	6.5 L (7.0 qts.)
Without Filter.....	5.7 L (6.0 qts.)

* Oil filter should be changed at every oil change.

** Add one additional quart for C3500 H.D. models

Fuel Tank

Short Bed Models.....	98.0 L (26 Gallons)
Long Bed Models.....	128.0 L (34 Gallons)
Four-Door Models (Standard).....	128.0 L (34 Gallons)
Chassis-Cab Models	
Standard (Side Tank).....	87.0 L (23 Gallons)

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Optional (Rear Tank)	117.0 L (31 Gallons)
3500 HD Models	
Standard (Side Tank).....	87.0 L (23 Gallons)
Optional (Rear Tank)	117.0 L (31 Gallons)

Transmission

4L60-E Automatic—Drain and Refill	4.7 L (5 qts.)
After Complete Overhaul.....	10.6 L (11 qts.)
4L80-E Automatic—Drain and Refill	4.7 L (5 qts.)
After Complete Overhaul.....	10.9 L (11.5 qts.)
New Venture Gear 4500 Manual	3.78 L (4 qts.)
New Venture Gear 3500 (5LM60) Manual	2.0 L (2.2 qts.)

ADJUSTABLE BELT TENSION SPECIFICATIONS

Belt tension is maintained by a spring tensioned idler pulley. No adjustment of the serpentine belt is necessary.

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NOTES

SECTION 0C

VIBRATION DIAGNOSIS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

VIBRATION DIAGNOSIS

Vibration is a back and forth oscillation that can be seen, heard, or felt. Imbalance or misalignment of the vehicle is usually the cause of a vibration.

PATH, SOURCE, AND RESPONDER

In many cases the vibration that is being seen, heard, or felt is not the source but the responder (figure 1). Many times the severity of the vibration will depend on how it is transmitted through the vehicle.

VIBRATION CLASSES

Vibration problems can be classified into four sensitivity categories. Many problems fit into more than one of the categories. These categories can usually be combined into one of the following "classes" of categories:

- A. Engine Speed Sensitive Only
- B. Vehicle Speed Sensitive Only
- C. Torque Sensitive and Vehicle Speed Sensitive
- D. Torque Sensitive and Engine Speed Sensitive
- E. Torque Sensitive, Vehicle Speed Sensitive, and Jounce Sensitive.

The first step in correcting a vibration problem is to determine which of the above best describe the problem. The second step is to determine the vehicle speed and rpm at which the vibration occurs or is most intense.

ORDERS OF VIBRATION

Some components vibrate more than others at a given speed. These multiple vibrations are referred to as the order of vibration. The order of a vibration is defined as the number of disturbances created by one rotation of a component. For example, a tire with one heavy spot will produce one disturbance each rotation - a first order vibration. An oval shaped tire will produce two disturbances each rotation - a second order vibration (figure 2).

VIBRATION CATEGORIES

There are several excitation sources and many responding systems which may cause a vibration complaint. Most vibrations are caused by wheel and tire disturbances or driveline imbalances. Each of these categories has a specific vibration associated with it. By systematically classifying the vibration into one of the following categories you can eliminate many components as the source.

VEHICLE SPEED SENSITIVE

Most vibration complaints will be found to be vehicle speed sensitive. The frequency of the vibration depends only on the speed of the vehicle.

Vehicle speed sensitivity can be determined as follows:

1. Drive the vehicle in high gear and locate the vibration problem. Record the vehicle speed and the rpm at which the problem occurs.
2. Shift the vehicle into a lower gear and again locate the vibration problem. Record the vehicle speed and the rpm at which the problem occurs.
3. If the problem occurs at the same vehicle speed as when the vehicle was in high gear, the vibration is vehicle speed sensitive.
4. Place the transmission in neutral or park position and slowly increase engine rpm to determine and engine-speed related vibration. Record the rpm at which the vibration occurs.

ENGINE SPEED SENSITIVE

Another group of vibration complaints will be found to be engine speed sensitive. The frequency of the vibration depends only on the speed of the engine, independent of the speed of the vehicle.

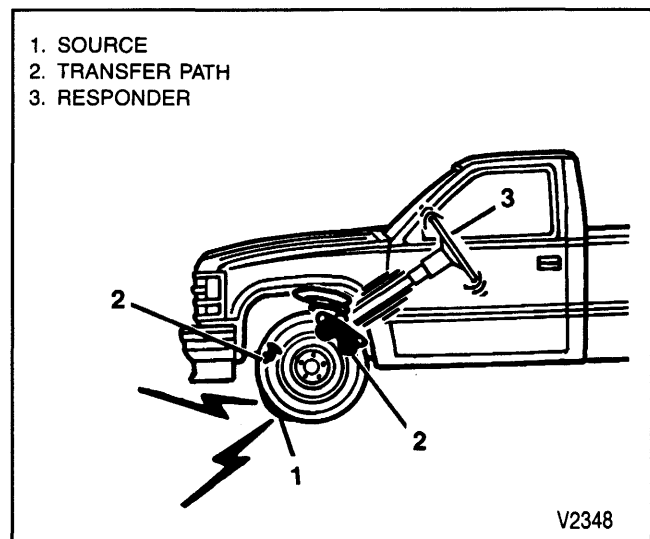


Figure 1—Vibration Source, Path, Responder

Engine speed sensitivity can be determined as follows:

1. Drive the vehicle in high gear and locate the vibration problem. Record the vehicle speed and the rpm at which the problem occurs.
2. Shift the vehicle into a lower gear and again locate the vibration problem. Record the vehicle speed and the rpm at which the problem occurs.
3. If the problem occurs at the same rpm as when the vehicle was in high gear, the vibration is engine speed sensitive.

PAYLOAD OR JOUNCE SENSITIVE

A payload or jounce sensitive problem is one which varies in intensity as the height of the vehicle changes with respect to the surface of the road. The intensity varies as the springs are extended or compressed.

Payload or jounce sensitivity can be determined as follows:

1. Drive the vehicle and observe the disturbance with varying payload.
2. Drive the vehicle over a road that dips in such a way that it causes the rear of the vehicle to move up and down relative to the surface of the road. Keeping a constant throttle, notice when the disturbance occurs.
3. If the disturbance occurs when the vehicle height is changed due to the payload, or it occurs on roads that cause the vehicle to dip, this can be determined as payload or jounce sensitive.

TORQUE SENSITIVE

A torque sensitive problem is one which increases in intensity as the torque (power) output of the engine increases. The intensity of the vibration increases as the throttle opening is increased.

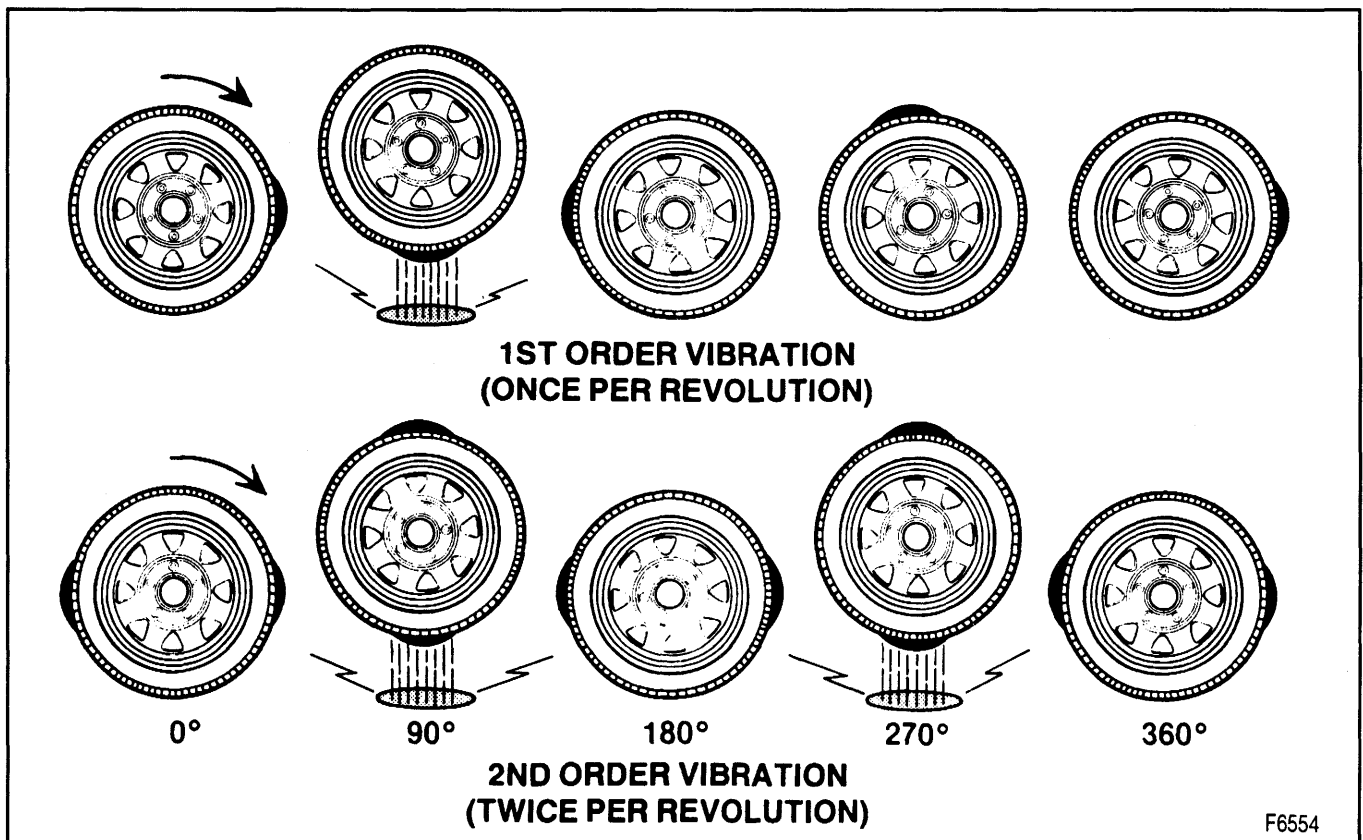
Torque sensitivity can be determined as follows:

1. Drive the vehicle in high gear and locate the vibration. Record the vehicle speed and rpm at which the problem occurs.
2. Note the vibration while varying the throttle position. Drive the vehicle with steady throttle, slowly increasing to heavy throttle by going up hill. Or apply the brakes while increasing the throttle opening then slowly decrease to minimum throttle and coast during the vibration.
3. If the vibration becomes more severe as the throttle opening is increased, the vibration is torque sensitive. This typically changes the pinion angle.

ROAD TESTING

To help diagnose and isolate the source of a vibration, it is important to road test the vehicle and use a systematic approach in narrowing down the possible causes of a vibration.

1. When did the vibration start?
2. Did the vibration start after a repair procedure in any of the following areas?
 - Exhaust System
 - Undercoating
 - Tire Repair or Replacement
 - Wheel Alignment
 - Engine Repair



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Figure 2—Order of Vibration

OC-4 VIBRATION DIAGNOSIS

These questions will give you a basic outline and will enable you to eliminate many components and focus attention on only those items that can be responsible for the conditions encountered.

Four major component groups are usually the cause of or are related to vibration. When road testing a vehicle for vibration, remember these groups:

- Engine and mounts.
- Tires, wheels, and brake drums.
- Propeller shaft and universal joints.
- Transmission or transfer case mounts.

Before road testing a vehicle, check the following:

1. In-or-out of phase propeller shaft.
2. All fasteners for tightness at universal joints, wheel lugs, engine mounts, transmission, or transfer case mounts.
3. Tire air pressure.
4. Payload conditions.

ROAD TEST

Road test the vehicle to diagnose the complaint. Refer to "Reed Tachometer" or "Electronic Vibration Analyzer (EVA)." Record the speed and rpm at which the greatest vibration occurs. The vibration is likely to be felt in the steering wheel or in the seat bottom. The road test can be helpful in locating the vibration source either forward or aft.

COAST TEST

Drive the vehicle past the vibration speed, shift into neutral, and coast back through the vibration speed. In this test two kinds of vibrations normally occur; a shaking or a buzzing. A shaking vibration is usually caused by tires or a wheel and brake assembly problem. A buzzing vibration is usually caused by a driveline problem.

SPECIAL TOOL DESCRIPTION (VIBRATION DIAGNOSIS)

Special tools can be used to identify the frequency of a rotational component with a repetitive vibration. These tools consist of a reed tachometer or an electronic vibration analyzer (EVA).

REED TACHOMETER

The Biddle Frahm reed tachometer (or equivalent) measures vibration in cycles per minute (CPM) (figure 3). It consists of two rows of reeds. Each row is designed to vibrate at a particular frequency.

If you can match the rotational speed of a particular component with the frequency reading of the reed tachometer, you will know in which area to concentrate your efforts for repairs.

These frequency relationships exist for all vibrations that occur in a vehicle and understanding these relationships can often solve difficult vibration problems.

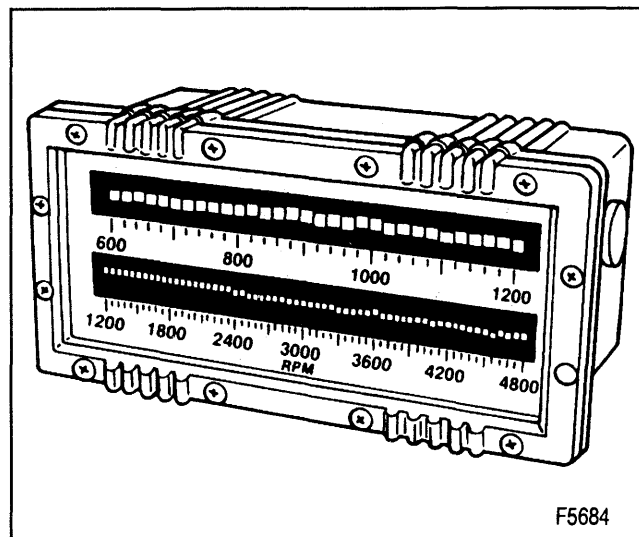


Figure 3—Reed Tachometer

REED TACHOMETER USAGE

The best place to put the reed tachometer in a truck is on top of the instrument panel. This is an effective location for picking up vibration and providing ease of viewing.

However, if the vibration frequency cannot be read with the reed tachometer on the instrument panel, it can be placed in other locations that may be responding to the source of the vibration. To reduce the effect of road surface, vehicles should be test driven on a smooth road (preferably asphalt).

An important thing to be aware of when using the reed tachometer for the first time is that the reeds are very sensitive and will pick up many low amplitude vibrations (figure 4). These will appear as slight movements of many reeds, and do not correspond to any particular component. Reed movement that corresponds to a vibrating component will be greater in amplitude, traveling the full range of the viewing area.

The following examples illustrate two typical applications of a reed tachometer. The electronic vibration analyzer (EVA) can be substituted for the reed tachometer. Refer to "Electronic Vibration Analyzer."

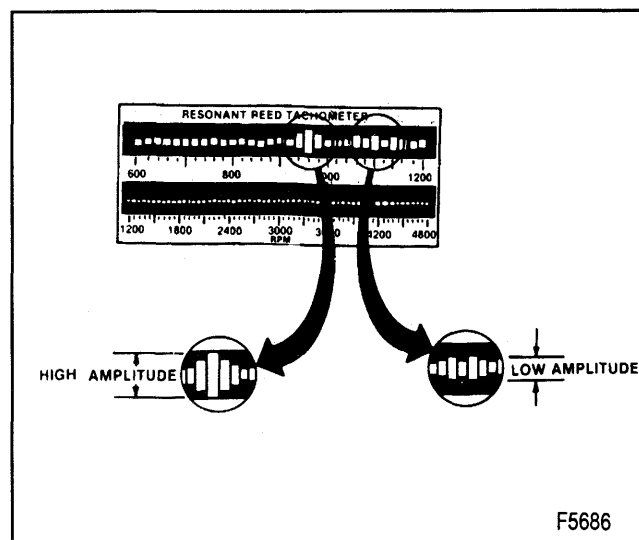


Figure 4—Amplitude

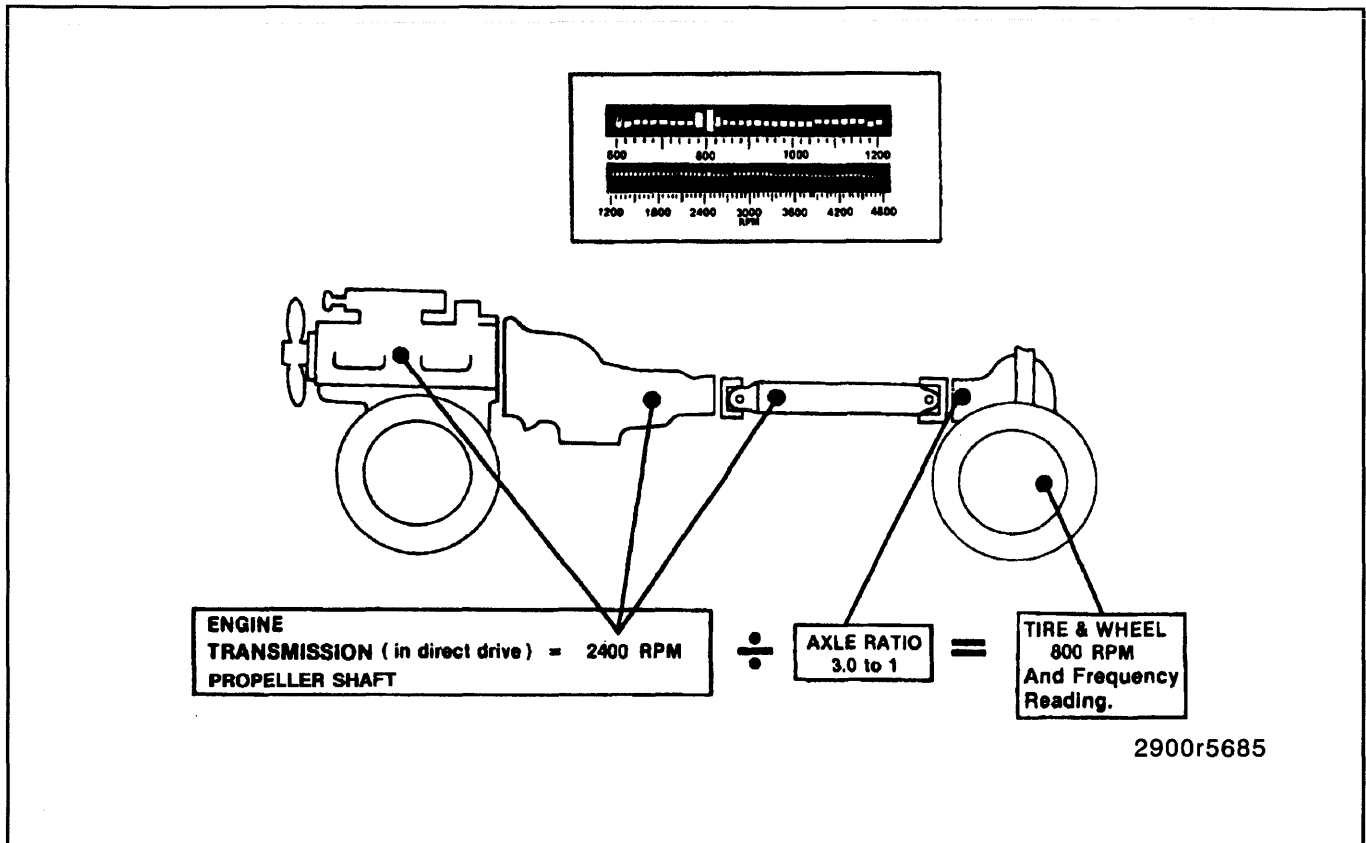


Figure 5—Reed Tachometer 1st Order Vibration

Example 1

Road test reveals low frequency (shake) vibration at 2400 rpm with the transmission in direct drive.

Known facts - Reed tachometer frequency reads at 800 cycles per minute (figure 5).

Vibration is vehicle speed sensitive.

Rear end ratio 3.0 to 1.

Calculations - First order of tire and rear end: 2400 rpm and 3.0 to 1 rear axle ratio = 800 rpm.

First order of propshaft: 2400.

Conclusion - The vibration frequency (800) is related to the first order rotation of the tire/wheel assembly. Given this relationship, you can correct the tire/wheel assembly for a first order disturbance.

Example 2

Road test reveals high frequency vibration at 2400 rpm with the transmission in direct drive.

Known facts - Reed tachometer frequency reads at 1600 cycles per minute (figure 6).

Vibration is vehicle speed dependent.

Rear end ratio 3.0 to 1.

Calculations - First order of tire and rear end: 2400 rpm and 3.0 to 1 rear axle ratio = 800 RPM.

First order of tire and wheel: 800.

Second order of tire and wheel: 800 x 2 = 1600.

Conclusion - The vibration frequency 1600 is related to the second order rotation of the tire and wheel.

TIRE SPEED CHART

Tire Size	Tread	Revs/Sec at 5 mph
P235/75R15	ALS	1.00
	OOR	0.99
P275/60HR15	AL3	1.03
31X10.5R15/B	OOR	0.95
LT225/75R16	ALS	0.99
	OOR	0.98
LT245/75R16	ALS	0.95
	OOR	0.94
LT265/75R16	OOR	0.90
LT215/85R16	HWY	0.95
	OOR	0.94
LT235/85R16	HWY	0.91
	OOR	0.90
7.50R16	HWY	0.90
	OOR	0.90
8.75R16.5	HWY	0.98
225/70R19.5	HWY	0.89
AL3=Performance (GT+4) ALS=All Season HWY=Highway OOR-On/Off Road		

T2840

OC-6 VIBRATION DIAGNOSIS

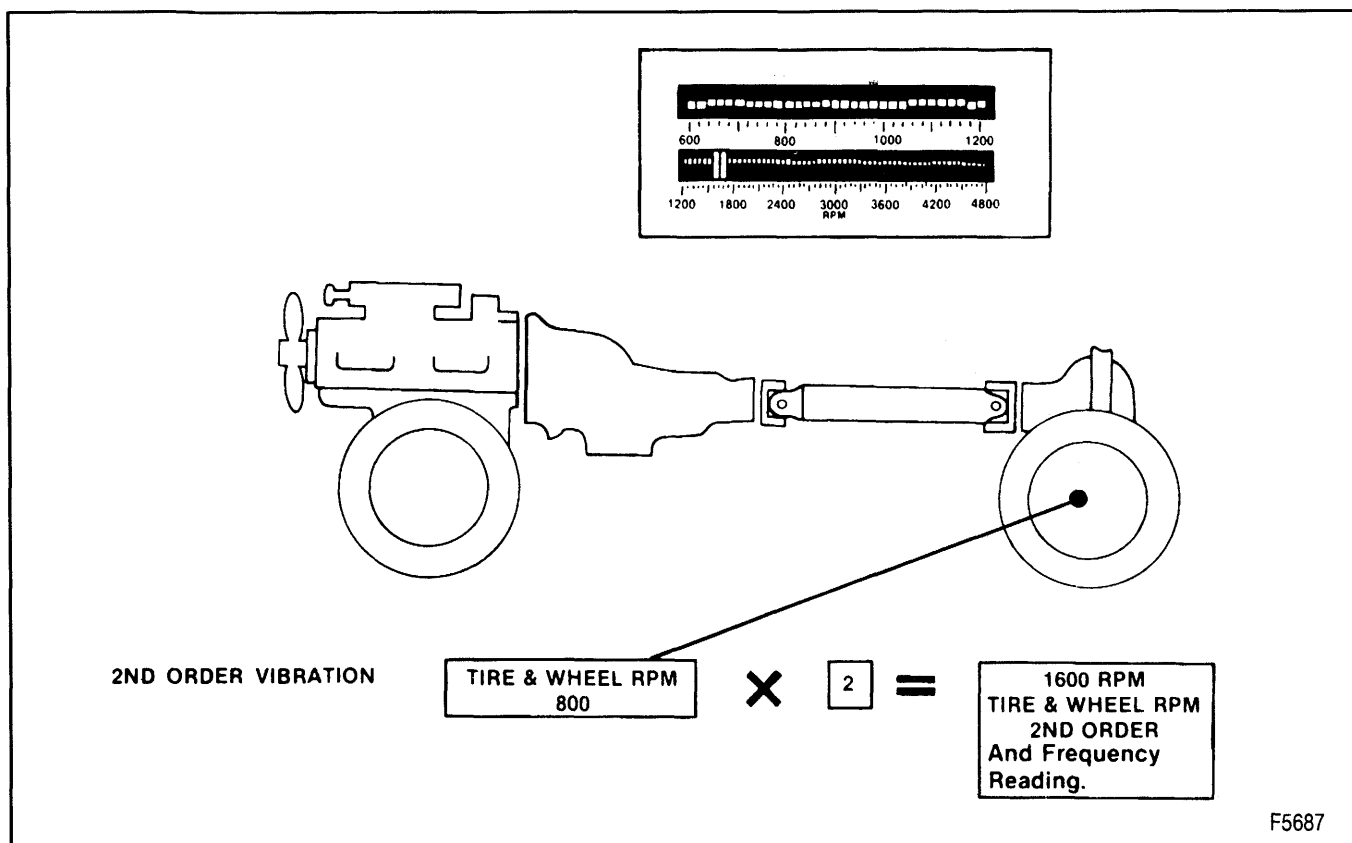


Figure 6—Reed Tachometer 2nd Order Vibration

ELECTRONIC VIBRATION ANALYZER (EVA)

The Electronic Vibration Analyzer (EVA) J 38792 speeds up the diagnosis of vibrations by displaying the three most predominant frequencies and their amplitudes. These frequencies are displayed in bar graph form. The strongest vibration is displayed first, the next strongest second, and the weakest displayed last (figure 7).

The EVA is equipped with a vibration sensor that can be plugged into either input A or input B on the front of the EVA. The vibration sensor can be mounted almost anywhere on the vehicle by using a magnet or adhesive putty. There is a trigger wire on the front of the EVA that a strobe light pickup can be attached to for driveshaft balancing (figure 8).



Important

- The vibration sensor is marked with the word "UP" on one side. For the sensor to accurately and consistently pickup vibrations, it must be mounted as close as possible to the source of the vibration in the horizontal position with the "UP" identification facing up. Refer to the instruction manual accompanying the EVA for sensor calibration.

SPECIAL TOOL DESCRIPTION

COMPANION FLANGE RUNOUT GAGE

A good place to start when diagnosing a vibration problem, is to consider pinion flange runout. Pinion flange runout affects the rear of the propshaft by moving it off its center rotating point. A pinion flange with excessive runout will have the same effect on the vehicle as a propshaft with excessive runout.

To measure pinion flange runout use J 35819 Companion Flange Runout Gage. When working with larger pinion flanges, use the runout gage adapter sleeves J 35819-100. A dial indicator with a magnetic base or a clamp base will also be needed.

INCLINOMETER

Drive line angles do not refer to the angle of the propshaft alone, but to the angle where the propshaft meets the front yoke or rear yoke on vehicles with a one-piece propshaft, and where the propshafts intersect on vehicles with a two-piece propshaft. The front and rear yokes must be included when measuring a two-piece propshaft system. The special tool used for checking driveline angles is J 23498-A, an inclinometer.

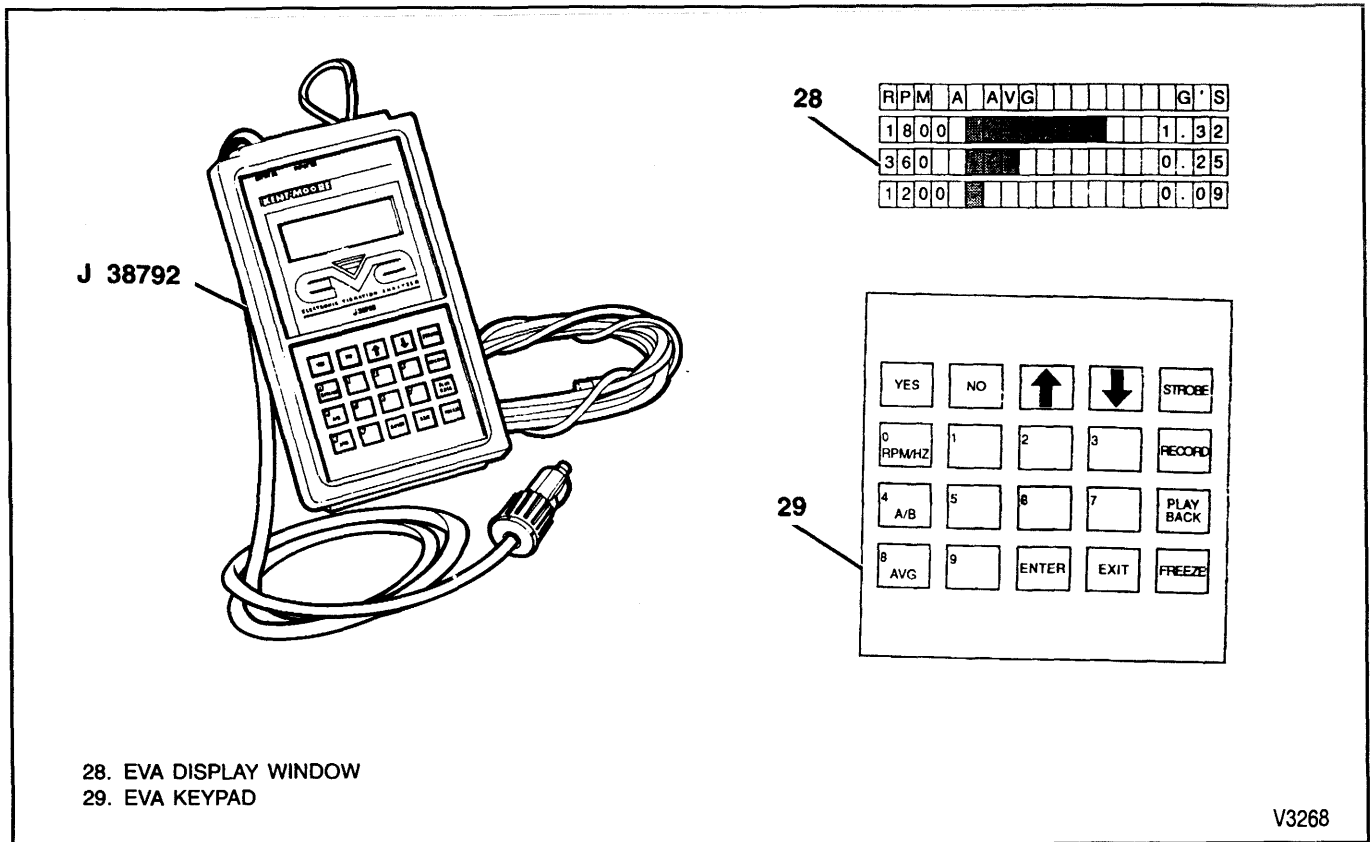


Figure 7—Electronic Vibration Analyzer (EVA)

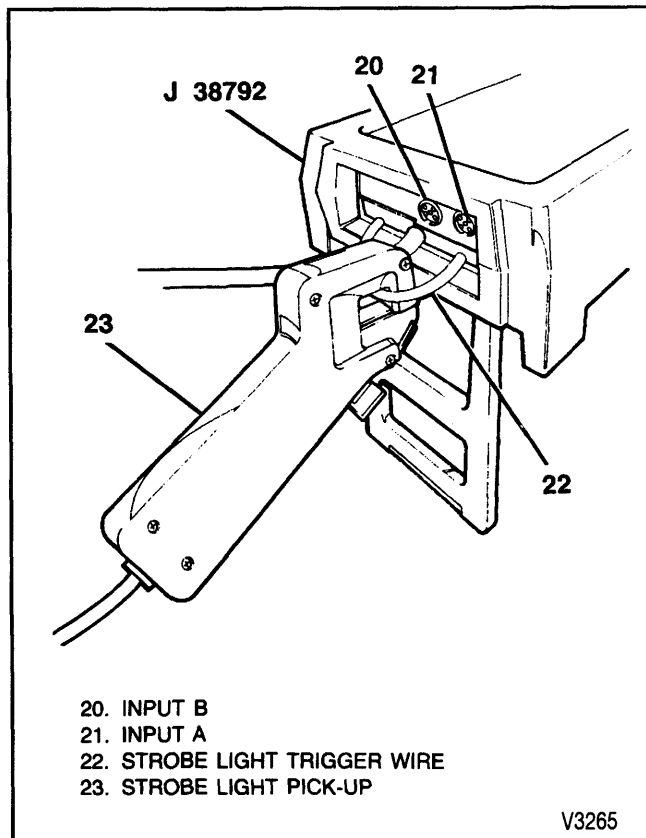


Figure 8—EVA Inputs and Connections

ON-VEHICLE SERVICE—TIRE AND WHEEL VIBRATIONS

BALANCING TIRES AND WHEELS

There are two types of tire and wheel balancing; static and dynamic. Static balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp (figure 9). This condition will eventually cause uneven tire wear.

Dynamic balance is the equal distribution of weight on each side of the centerline so that when the wheel spins there is no tendency for it to move from side to side (figure 10). Wheels that are dynamically unbalanced may cause wheel shimmy.

GENERAL BALANCE PRECAUTIONS

Deposits of foreign material must be cleaned from the inside of the wheel. Remove stones from the tread to avoid operator injury during spin balancing and to obtain a good balance. The tire should be inspected for any damage, then balanced according to the equipment manufacturer's recommendations.

Whenever a heavier, solid locking wheel nut is used to replace a standard nut, it should be installed nearest the valve stem, and a 14 gram (1/2 ounce) balance weight should be added 180 degrees opposite the locking nut on the wheel's inboard side.

When rotating tires, always install the locking nut nearest the tire valve stem so that it remains opposite the balance weight. This procedure will improve the wheel balance by compensating for the heavy locking wheel nut.

OFF-VEHICLE BALANCING

Most electronic off-vehicle balancers are more accurate than the on-vehicle spin balancers. They are easy to use and give a dynamic (two-plane) balance. Although they do not correct for drum or rotor unbalance, like on-vehicle spin balancing, they are more accurate. When balancing off-vehicle, the wheel should locate on the balancer with a cone through the back side of the center pilot hole not by the wheel stud holes.

ON-VEHICLE BALANCING

On-vehicle balancing will help correct vibrations due to brake drum, rotor, and wheel cover imbalance.

When balancing on-vehicle, remove the balance weights from the off-vehicle dynamic balance. If more than 28 grams (one ounce) of additional weight is required, it should be split between the inner and outer rim flange.

! Important

- The driven tire and wheel assemblies should be spun using the engine. Limit speed as stated in the following Caution.

CAUTION: Do not spin the drive wheels faster than 35 mph (55 km/h) as indicated by the speedometer. This limit is necessary because the speedometer indicates only one-half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Personal injury and damage may result from high speed spinning.

CAUTION: On vehicles equipped with limited slip rear axles, do not attempt to balance a tire on a drive wheel with the other drive wheel on the ground. The vehicle may drive through this wheel and cause the vehicle to move unexpectedly, resulting in personal injury and property damage.

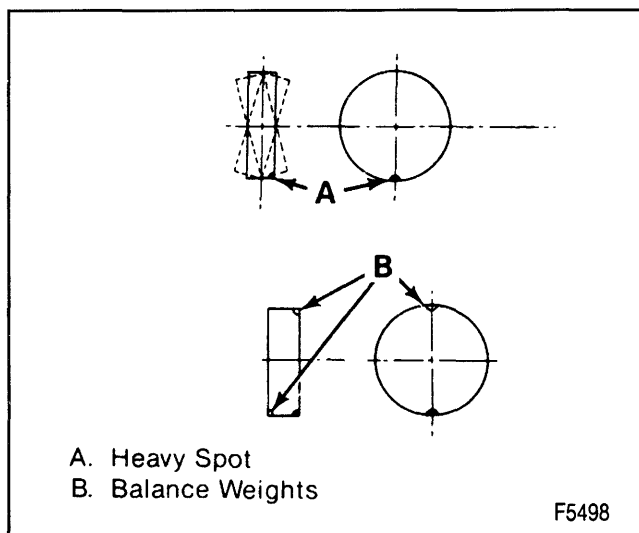


Figure 9—Static Unbalance

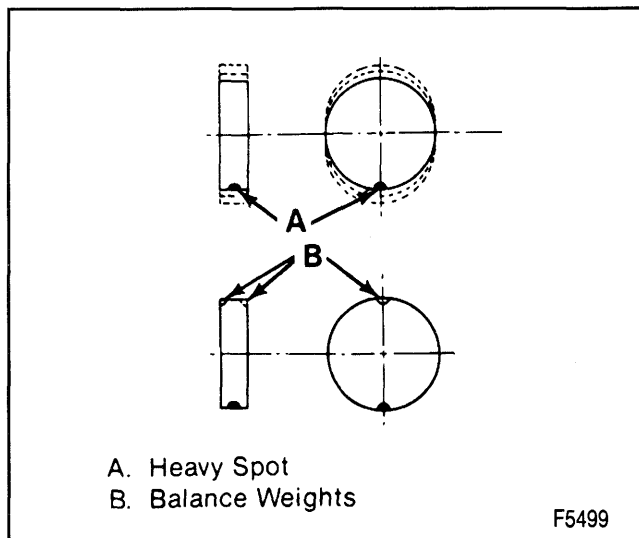


Figure 10—Dynamic Unbalance

To distinguish between a standard rear axle and a limited slip rear axle, check for Positraction (G80) on the Service Parts Identification label.

WHEEL WEIGHTS

If more than 85 grams (3 ounces) are needed, the wheel weights should be split as equally as possible between the inboard and outboard flanges.

Balancing of assemblies with factory aluminum wheels requires the use of special clip-on type wheel weights. These weights are designed to fit over the thicker rim flange of the aluminum wheel.

Adhesive wheel weights are also available. Use the manufacturer's procedures to install adhesive wheel weights.

WHEEL RUNOUT

Measure wheel runout with an accurate dial indicator. Take measurements with the wheel installed on the vehicle or off the vehicle using an accurate mounting surface such as on a wheel balancer. Measurements may be taken with or without the tire mounted on the wheel.

Radial runout and lateral runout should be measured on both the inboard and outboard rim flanges (figure 11). With the dial indicator firmly in position, slowly rotate the wheel one revolution and record the total indicator reading. If any measurement exceeds specifications, and there is vibration that wheel balancing will not correct, the wheel should be replaced. Disregard any indicator readings due to welds, paint runs, scratches, etc.

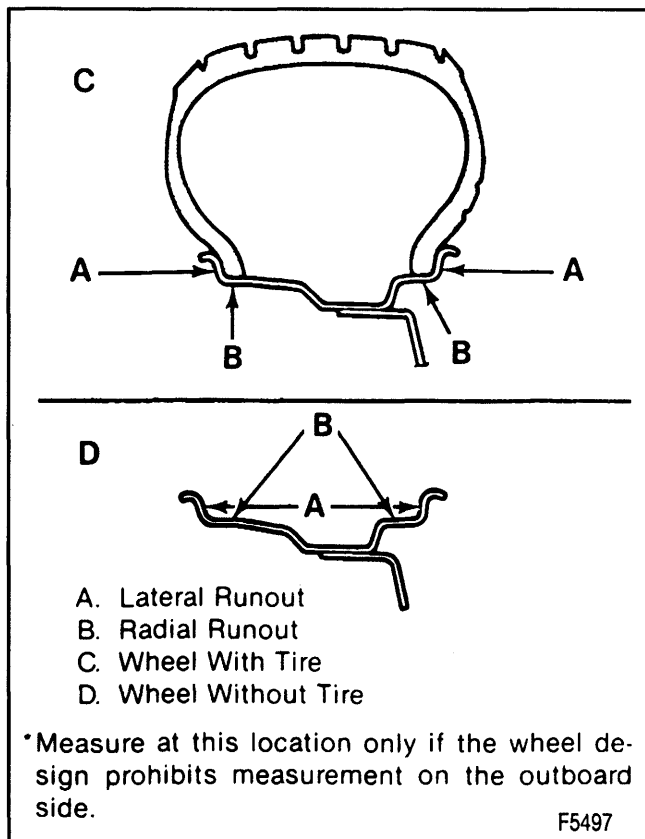


Figure 11—Wheel Runout

- **STEEL WHEELS:**
 - Radial runout..... 1 mm (0.040 inch)
 - Lateral runout..... 1.2 mm (0.045 inch)
- **ALUMINUM WHEELS:**
 - Radial runout..... 0.8 mm (0.030 inch)
 - Lateral runout..... 0.8 mm (0.030 inch)

TIRE/WHEEL ASSEMBLY RUNOUT

Before measuring the runout of a tire/wheel assembly, the vehicle should be driven long enough to warm up the tires. Do this before any measurements are taken, then do the following:

1. Lift the vehicle and support with suitable safety stands.
2. Mark the location of each tire/wheel assembly in relation to the wheel studs and to their position on the vehicle.
3. Install tire/wheel assembly on wheel balancer.
4. Using a dial indicator with a magnetic base and a roller tip, position it on the balancer so the different runout checks can be done (figure 12).
5. DO NOT start the wheel balancer with the dial indicator in place. These checks should be done by spinning the tire BY HAND ONLY on the tire balancer.
6. Slowly rotate the assembly one complete turn and "zero" the dial indicator on the low spot.
7. Rotate the assembly one more complete turn and note the amount of runout.

The maximum allowable radial and lateral runout is 1.3 mm (0.050 inch) when measuring off the vehicle, and 1.5 mm (0.060 inch) when measuring on the vehicle.

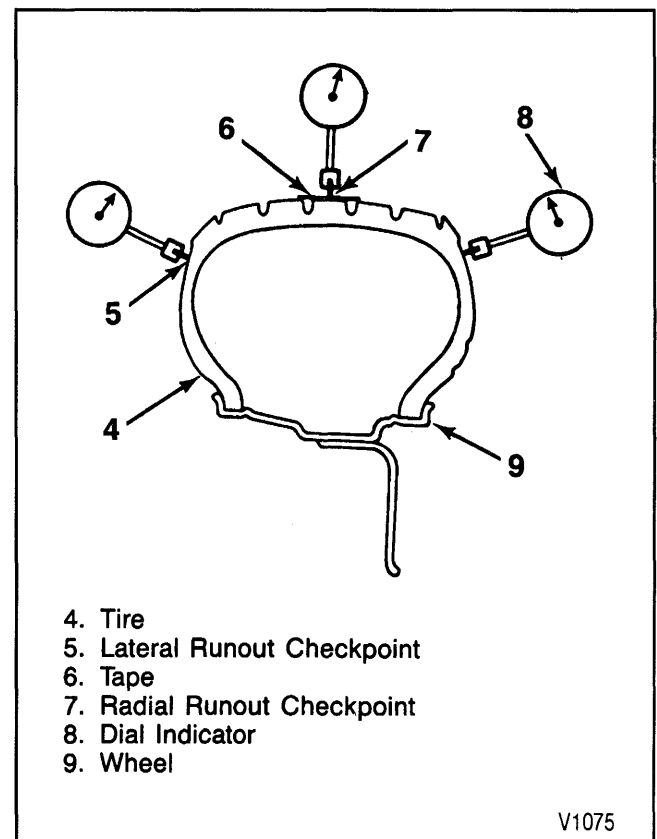


Figure 12—Measuring Radial and Lateral Runout

CORRECTING NON-UNIFORM TIRES

There are two ways to correct tires that cause a vibration even though they are properly balanced. One method uses an automatic machine which loads the tire and buffs small amounts of rubber from high spots on the outer two tread rows. Correction by this method is usually permanent and does not significantly affect the tire tread life.

Another method is to dismount the tire and rotate it 180 degrees on the rim. It is important that this be done on tire and wheel assemblies which are known to be causing a vibration as it is just as likely to cause good assemblies to vibrate.

HUB AND AXLE SHAFT STUD RUNOUT

When wheel and tire runout occurs on the vehicle and does not occur in off-vehicle testing, the hub and axle shaft should be checked (figure 13).

MEASURING ROTOR OR AXLE SHAFT RUNOUT



Install or Connect

The dial indicator on the machined surface outside the bolts on the rotor or axle flange (figure 13).



Measure

- Runout.
 1. Turn the rotor or axle flange to locate the low spot.
 2. Zero the dial indicator.
 3. Turn the rotor or axle flange to check the total lateral runout.
 - 0.130 mm (0.005 inch) is the acceptable lateral runout.

MEASURING AXLE SHAFT STUD RUNOUT



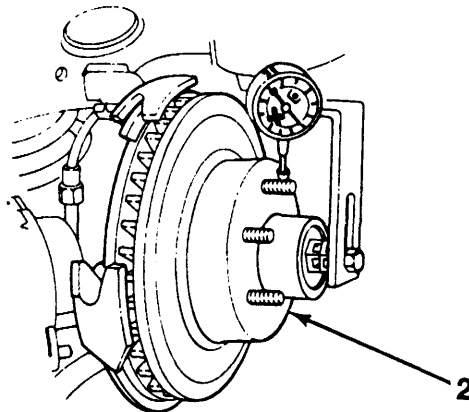
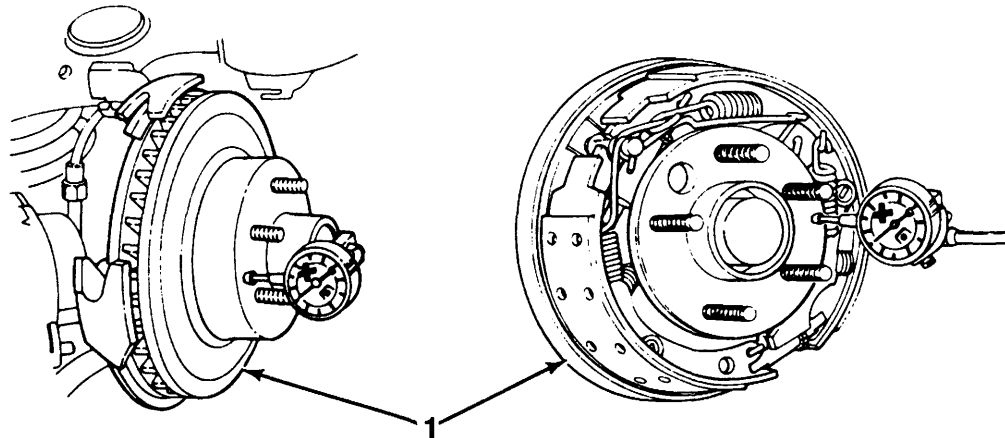
Install or Connect

The dial indicator to contact the wheel mounting studs (figure 13).



Measure

- Runout.
 1. Turn the hub to register on each of the studs.
 2. Zero the dial indicator on the lowest stud.
 3. Check the total runout on the remaining studs.
 - 0.8 mm (0.030 inch) is the acceptable radial runout.



1. Hub Lateral Runout
2. Stud Radial Runout

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Figure 13—Hub and Axle Shaft Stud Runout

ON-VEHICLE SERVICE—DRIVELINE VIBRATIONS

Driveline vibrations will generally produce a high speed vibration, a "buzz" or "shudder." With tire and wheel speeds in the 45-50 mph range, the average tire and wheel speeds are 600 rpm. A driveline will turn at a higher rpm because of the gear ratios. Most driveline vibrations occur in the 45-55 mph range, and most usually become strongest on either acceleration or deceleration. Driveline vibrations come from four general areas:

1. Shaft Balance
2. Shaft Runout
3. Pinion Flange Runout
4. Companion Flange Runout
5. Joint Phasing
6. Driveline Angles

Most driveline vibrations that are associated with a "buzz" or "shudder" type vibration will also have a high frequency reading on the reed tachometer or the EVA. Refer to "Reed Tachometer" or to "Electronic Vibration Analyzer."

PROPELLER SHAFT RUNOUT CHECK

Noise vibration at high speed could be caused by a bent propeller shaft. The propeller shaft could have been damaged by rough handling or a collision. Check for propeller shaft straightness.

1. Raise the vehicle on a twin post hoist so the wheels can spin.
2. Attach a dial indicator having a magnetic base to a smooth place on the vehicle underbody.
3. Take dial indicator readings at the propeller shaft check points (figure 14).



Important

- Do not attach the dial indicator base at a weld.
4. With the transmission in neutral, hand rotate the axle pinion flange or the transmission yoke and take the necessary dial indicator readings on the propeller shaft. Record the readings. If the runout is over specification at one or more check points, rotate the propeller shaft 180 degrees at the pinion flange or companion flange. Reinstall and check the runout. If the runout is still over specification check the pinion or companion flange runout. Use a dial indicator and J 35819 Companion Flange Runout Gage before replacing the propeller shaft. Refer to figure 15. For models having a two-piece driveline, measure the rear propeller shaft runout first (figure 14). Reference mark the position of the rear propeller shaft yoke to the pinion flange or companion flange, then remove the rear propeller shaft. Measure the front propeller shaft runout on the tube and at the splined shaft end. If the runout exceeds the specifications found in figure 14, replace the shaft.
 - The runout of splined shaft end will affect the runout of the front measurement on the rear shaft.

5. Check the runout on the replacement propeller shaft. If the new propeller shaft runout is over specification, double-check the pinion flange runout (figure 15).



Important

- The splined end of the front propeller shaft is critical to the smooth operation of a two-piece driveline. Be sure the dial indicator readings are accurate.

PROPELLER SHAFT BALANCE CHECK



Remove or Disconnect

- Raise the vehicle on a twin post hoist so the wheels can spin.
1. Tire and wheel assemblies and the brake drums.

CAUTION: Do not apply the brake with the drums removed or personal injury and vehicle damage may occur.



Inspect

- Propeller shaft, universal joints, and attachments for mud, undercoating, or loose fasteners.



Clean

- Propeller shaft, universal joints, and attachments.



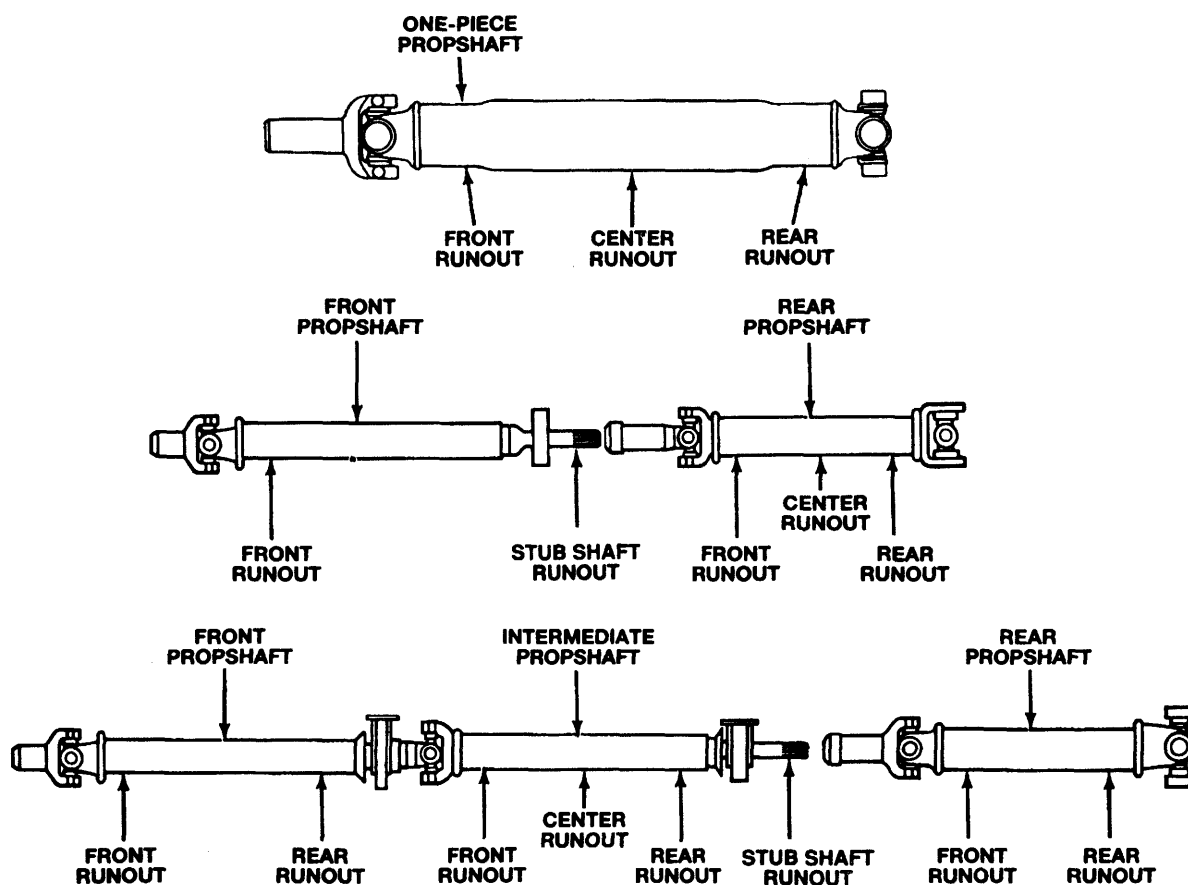
Tighten

- Any loose attachments or fasteners.



Important

- Run the vehicle in gear at the speed where the vibration peaks; observe the intensity of the vibration as indicated by the reed tachometer. The greater the disturbance, the greater the amount of amplitude that will be seen on the reed tachometer or the EVA. When using the reed tachometer or EVA to check propeller shaft balance, hold the reed tachometer or fasten the EVA sensor on a stationary component as close to the vibration as possible when reading the amplitude. Refer to "Reed Tachometer" or "Electronic Vibration Analyzer."
- Stop the engine.

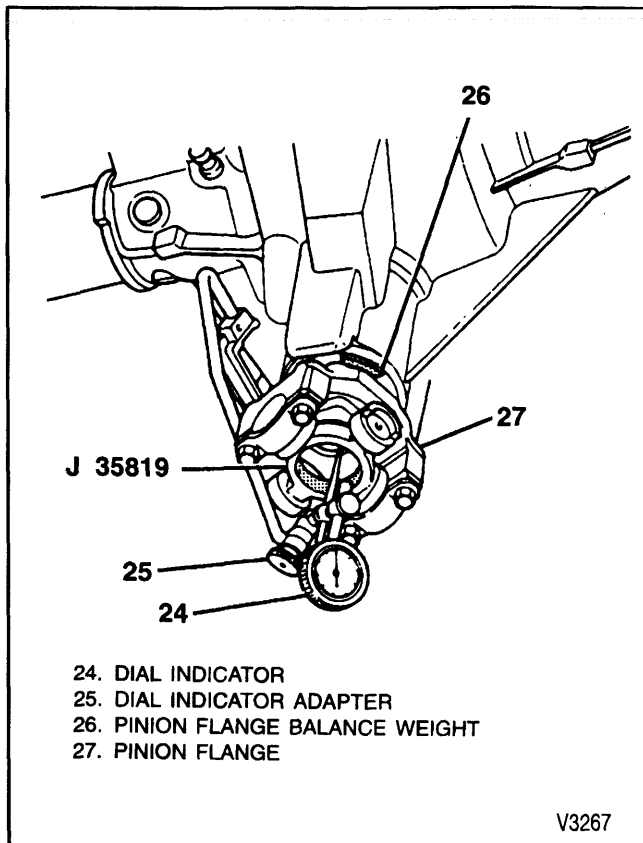


PROPSHAFT RUNOUT SPECIFICATIONS				
PROPSHAFT	FRONT RUNOUT	CENTER RUNOUT	REAR RUNOUT	STUB SHAFT RUNOUT
ONE-PIECE	0.040"	0.050"	0.055"	—
ALUMINUM GRAPHITE	0.040"	—	0.040"	—
TWO-PIECE FRONT SLIP YOKE	0.020"	—	—	0.003" ¹
TWO-PIECE FRONT FIXED YOKE	0.040"	—	—	0.004" ¹
TWO-PIECE REAR	0.030" ²	0.030"	0.035"	—
THREE-PIECE	0.025"	0.040"	0.040"	0.004" ¹

¹Take measurement on splines, 1/2-inch from the end.

²Measured with rear shaft disconnected from front shaft. Front shaft must be within runout tolerances.

Figure 14—Checking Propeller Shaft Runout


Figure 15—Pinion Flange Runout

2. Propeller shaft.

NOTICE: A screwdriver or bar should not be used in the universal joint/spider location, to rotate the propshaft because seal damage may result. Use a chain or strap wrench wrapped around the pinion flange to rotate propshaft.

- Rotate the propeller shaft 180 degrees from the original position.



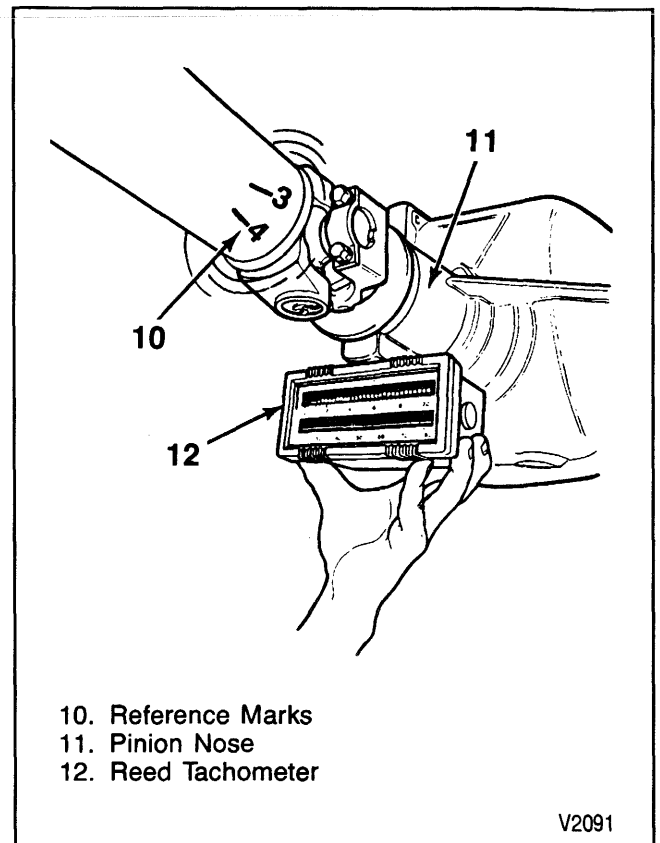
Install or Connect

1. Propeller shaft.
 - Determine the position which gives the lowest amplitude reading on the reed tachometer or EVA.
2. Rear drums, wheels, and tire assemblies.
 - Determine the position which gives the best driveline response by road testing the vehicle for a final check of the propeller shaft balance.
 - For unacceptable balance, refer to "Propeller Shaft Balancing."

PROPELLER SHAFT BALANCING

HOSE CLAMP METHOD (Figures 16, 17, and 18)

1. Place the vehicle on a twin-post hoist so that the rear of the vehicle is supported on the rear axle


Figure 16—Propeller Shaft Reference Marks and Reed Tachometer Position

- housing and the rear wheels are free to rotate. Remove both rear wheel assemblies and reinstall the wheel lug nuts with flat sides next to the drums.
2. Mark and number propeller shaft at four points 90 degrees apart at the rear of the propeller shaft just forward of the balance weights (figure 16).
3. Install two hose clamps on the rear of the propeller shaft and slide them rearward until the clamps stop at the nearest balance weight welded to the tube. Align both clamps at any one of the four marks made on the shaft in step 2 and tighten.
4. Run the vehicle through the speed range to 50-55 mph (81-89 km/h). Note the amount of imbalance felt at the front of axle housing or as indicated by a reed tachometer or the EVA sensor. Refer to figures 16 and 17.

CAUTION: Never run vehicle higher than 55 mph (89 km/h). All persons should stay clear of universal joints and balance weight areas to avoid possible injury. Do not run the vehicle on the hoist for extended periods due to the danger of overheating the transmission or engine.

5. Loosen clamps and rotate clamp heads 90 degrees to the next mark on the propeller shaft. Tighten clamps and repeat step 4.
6. Repeat step 5 until vehicle has been run with clamp heads located at all four marks on shaft.

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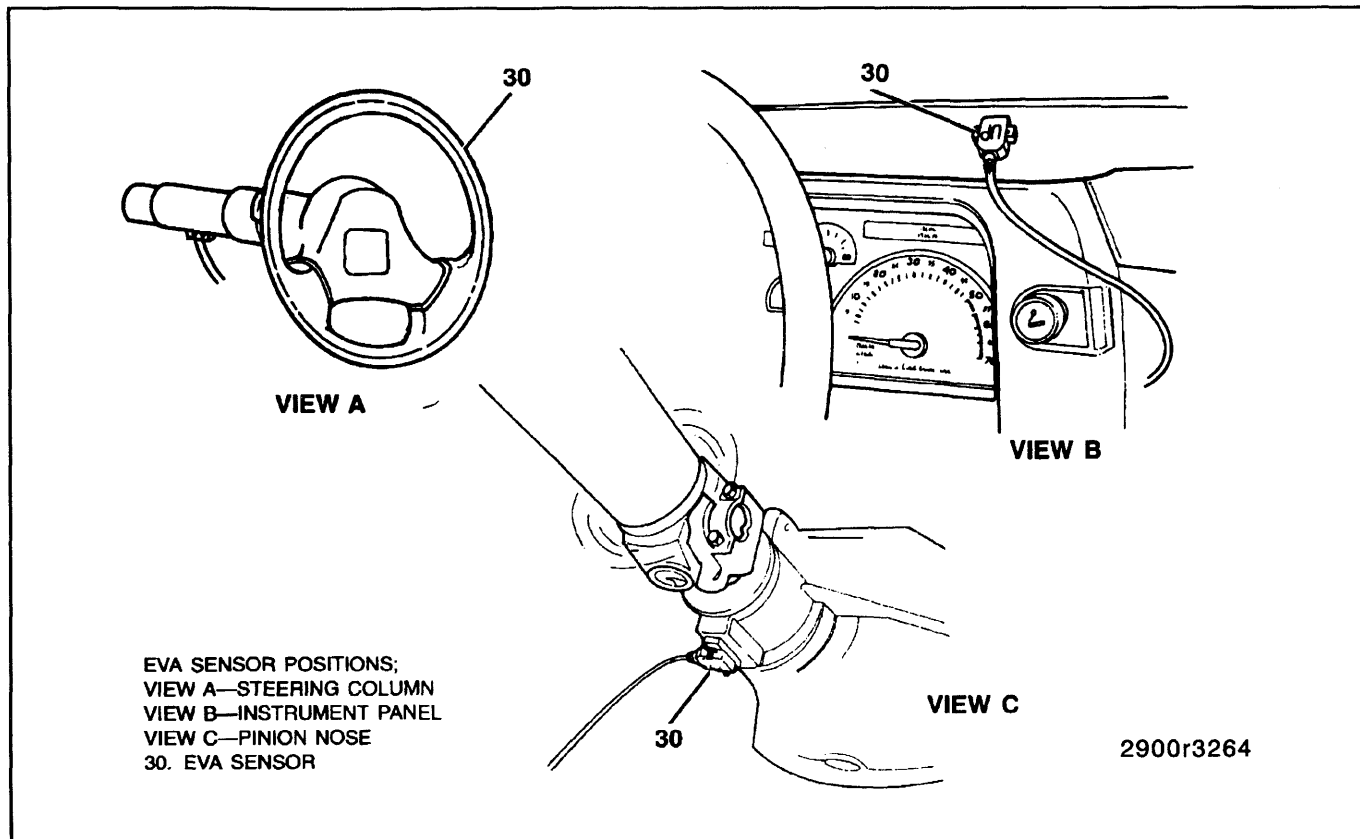


Figure 17—EVA Sensor Positions

7. Position clamps at point of least imbalance. Rotate the clamp heads away from each other 45 degrees (one on each side of the position) (figure 18). Run the vehicle and note if balance has improved. In some cases it may be necessary to use one clamp or possibly three clamps in order to obtain a good balance. Replace the propeller shaft if three hose clamps do not improve the balance.
8. Continue to rotate the clamps apart in smaller angular increments until the balance of the propeller shaft is achieved.

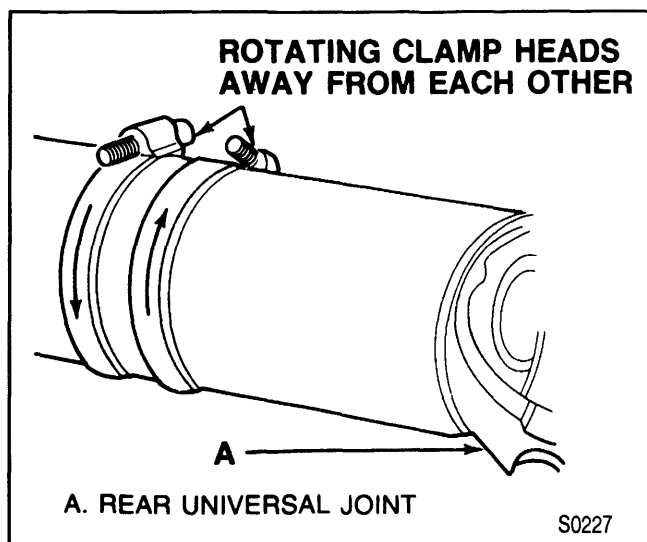


Figure 18—Rotating Hose Clamps

9. Reinstall wheel assemblies and road test the vehicle for final check of balance. A minimal vibration felt in the vehicle on the hoist may not show up during a road test.

STROBE LIGHT METHOD (Figures 8, 19, and 20)

Either a strobe light wheel balancer or an EVA can be used to balance a propeller shaft. The balance pickup unit should be placed directly under the nose of the axle carrier and as far forward as possible. When using the EVA for propshaft balancing, connect the strobe light to the trigger wire on the front of the EVA. By pushing the strobe button on the EVA's keypad, the EVA will go into the strobe mode, allowing the strobe light to flash.

1. Place the vehicle on a twin post hoist so the rear of the vehicle is supported on the rear axle housing and the rear wheels are free to rotate. Lower the hoist and allow the axle to rest on jackstands. Leaving the axle in the hoist fixture can destroy the sensitivity of the operation. Remove both rear wheel assemblies and reinstall wheel lug nuts with flat sides next to the drums.
2. Mark and number the propeller shaft at four points 90 degrees apart at the rear of the propeller shaft just forward of the balance weights, as shown in figure 16.
3. Place the strobe light wheel balancer pickup or the EVA sensor under the nose of the carrier (figures 17 and 19).

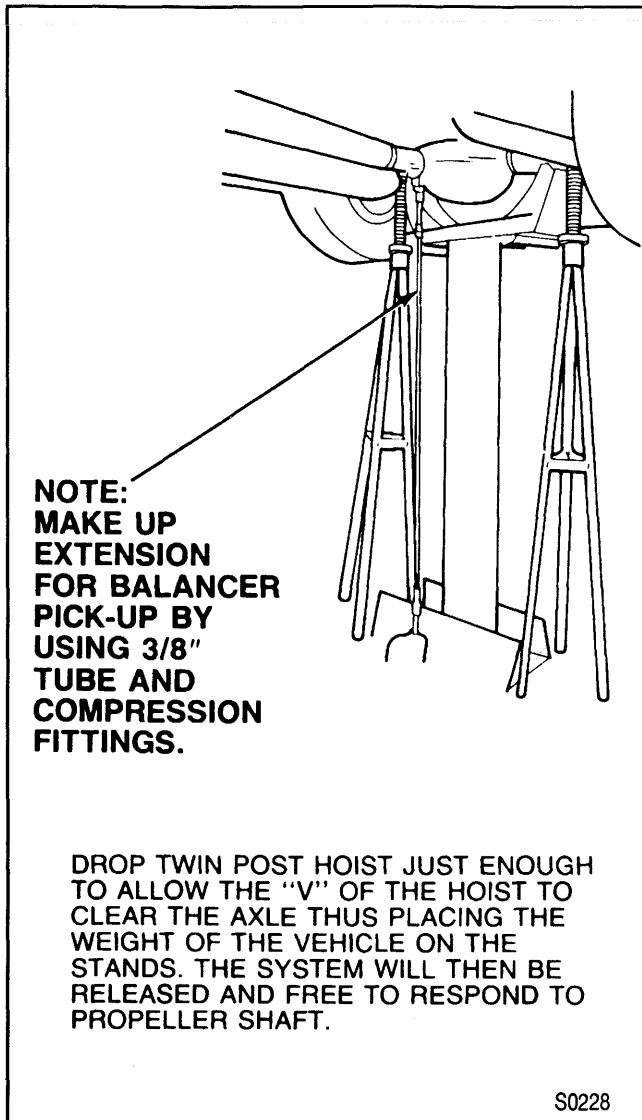


Figure 19—Pickup Unit Replacement

4. Run the vehicle in gear at the speed where the disturbance is at its peak, as indicated by driver input and by use of a reed tachometer or EVA holding at a constant speed. Point the strobe light up at the spinning propeller shaft and note the position of one of the reference numbers. Shut the engine off and position the propeller shaft so the reference numbers will be in the same position as was noted while the shaft was rotating. When the strobe light flashed, the heaviest point of the propeller shaft was at the bottom (6 o'clock). To balance the propeller shaft, it is necessary to apply the balancing weights (hose clamps) 180 degrees away from the heaviest point or at the top of the propeller shaft (12 o'clock).
5. Install two screw-type hose clamps on the propeller shaft as close to the balance weight and rear of the propeller shaft as possible. Position both clamp heads 180 degrees from the heaviest point on the propeller shaft as indicated by the strobe light. Tighten clamps.
6. Run the vehicle through the speed range. If disturbance is gone, nothing further need be done on the hoist. If the disturbance is not gone, and the strobe light shows the clamp heads at the bottom (6 o'clock) of the propeller shaft, go to step 7. If the strobe light shows the two clamp heads at the top of the propeller shaft, add one more hose clamp and recheck. If the strobe light shows the three clamp heads at the top of the propeller shaft, remove the propeller shaft and re-index it 180 degrees on the rear axle pinion flange. Recheck without clamps. Repeat balance starting with step 5. If the propeller shaft still needs more than three hose clamps at the same clock position, replace it.

! Important

- Before replacing the propeller shaft double-check the pinion flange runout (figure 15).

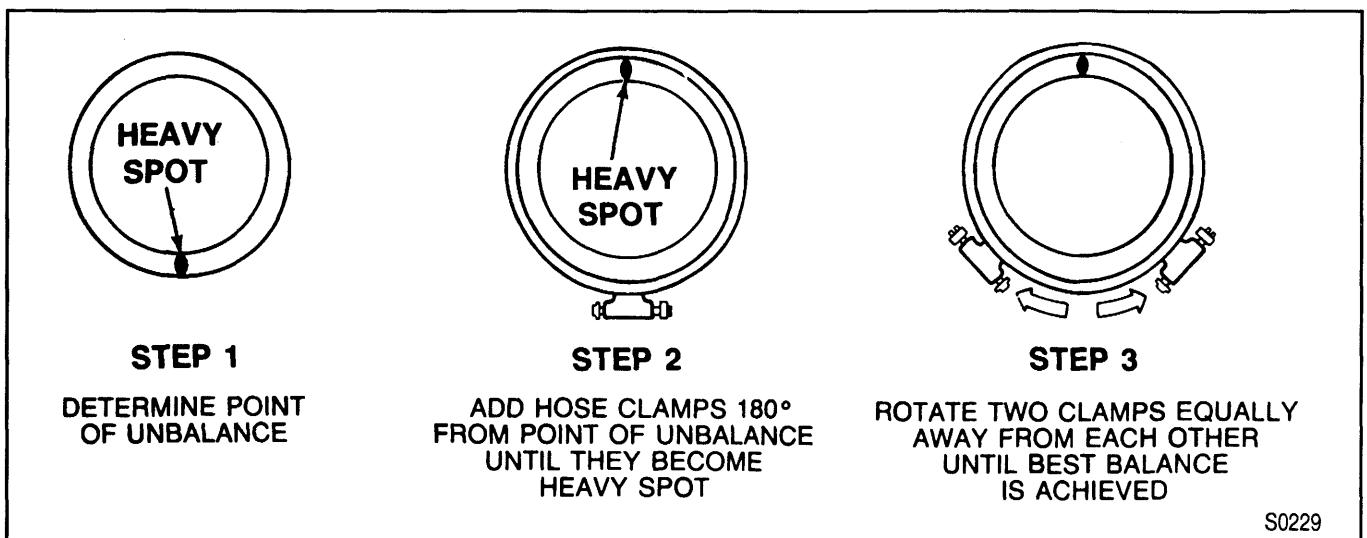


Figure 20—Positioning Hose Clamps to Achieve Best Balance

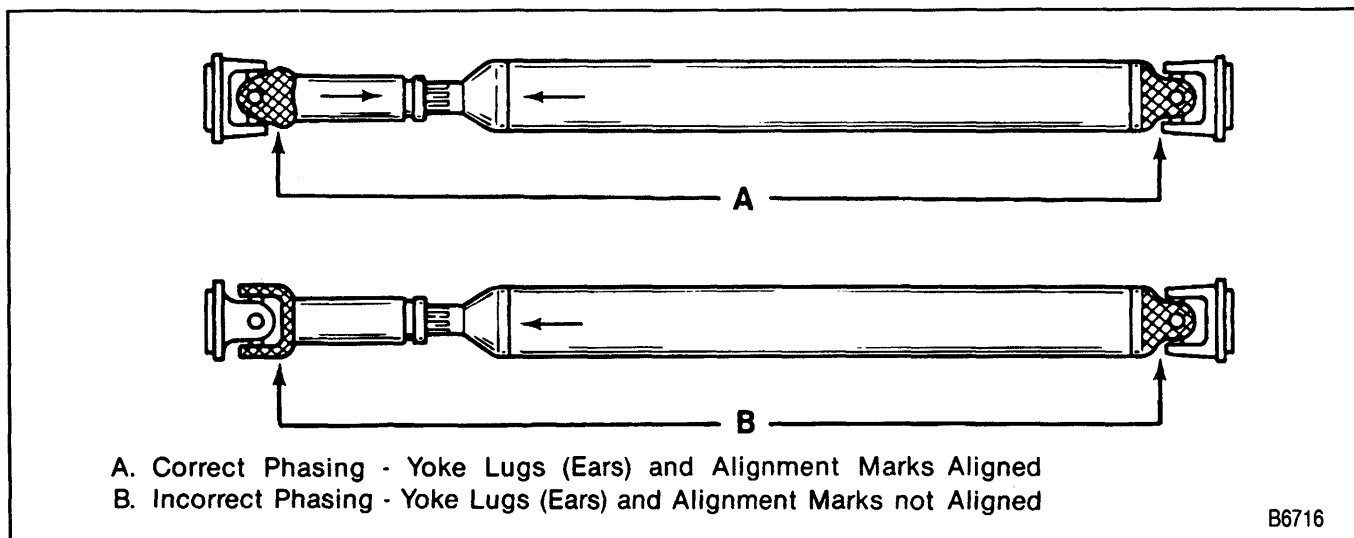


Figure 21—Phasing

If the clamps are 180 degrees from their original position after the propeller shaft was reindexed, the axle pinion flange is out of balance and must be replaced. DO NOT use more than three hose clamps to balance the propeller shaft. If the strobe light shows the hose clamps at the bottom of the propeller shaft, but the disturbance still exists, go to step 7.

7. Rotate two of the hose clamps equal distances away from each other toward the top (one on each side of the position) in small increments until the best balance is achieved (figure 20). In some cases, it may be necessary to use one clamp or possibly three clamps in order to obtain a good balance. Replace the propeller shaft if three hose clamps do not correct the problem.
8. Install the wheels and road test the vehicle for a final check of balance. Vibration felt in the vehicle on the hoist may not show up during a road test.

PROPELLER SHAFT PHASING

The propeller shaft is designed and built with the yoke lugs (ears) in line with each other. This design produces the smoothest running shaft possible, and is called phasing (figure 21).

Vibration can be caused by an out-of-phase propeller shaft. The propeller shaft will absorb vibrations from speeding up and slowing down each time the universal joint goes around. A total cancellation of vibration produces a smooth flow of power in the driveline.

DRIVELINE ANGLES

When two shafts intersect at any common universal joint, the bend that is formed is called the working angle (figure 22). The larger the working angle, the greater the amount of acceleration and deceleration of the universal joint. For every revolution of the propeller shaft, there are two accelerations and decelerations of the

universal joints. This speeding up and slowing down of the universal joint must be cancelled out to produce a smooth power flow. This is done through phasing and proper universal joint working angles.

MEASURING DRIVELINE ANGLES

Driveline angles can be measured using an inclinometer. Support the vehicle at curb weight with a full tank of gasoline. Install the J 23498-A inclinometer on the propeller shaft bearing cap (figure 23).

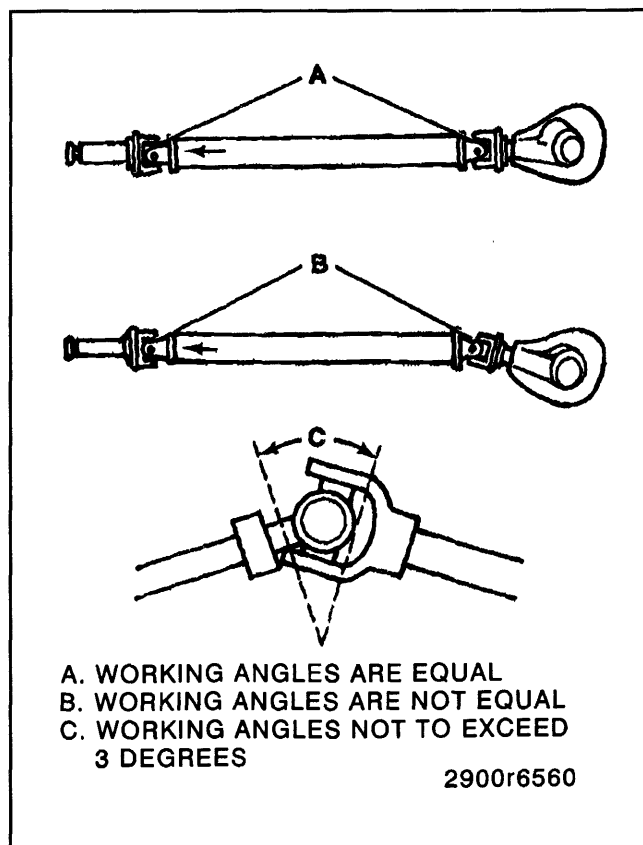


Figure 22—Working Angles

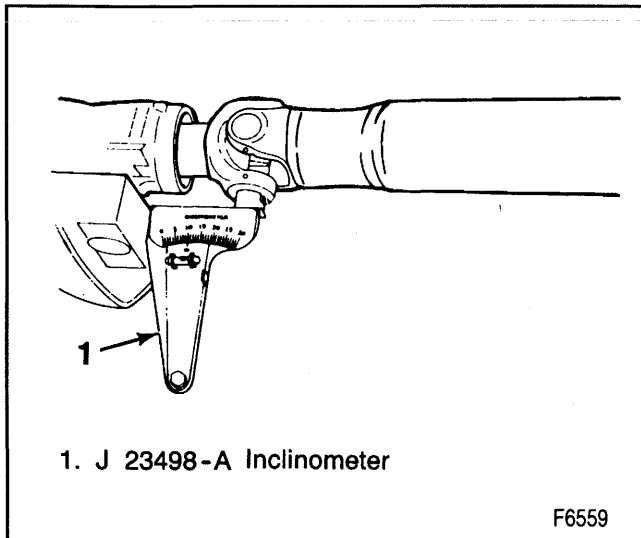


Figure 23—Measuring Driveline Angles

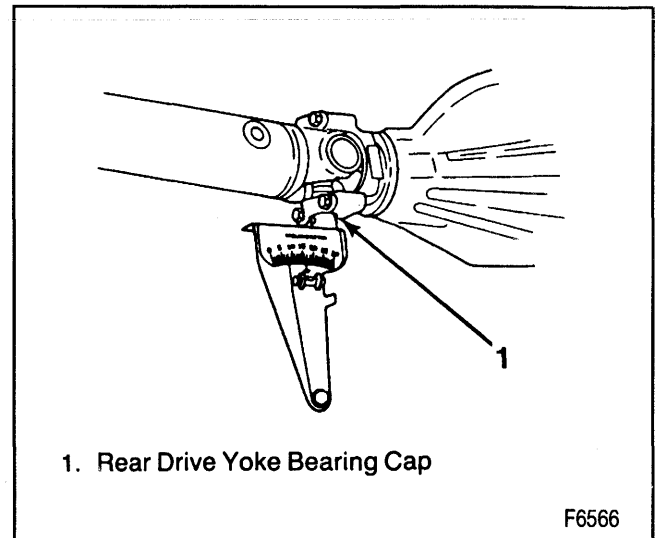


Figure 25—Measuring Rear U-Joint Working Angle

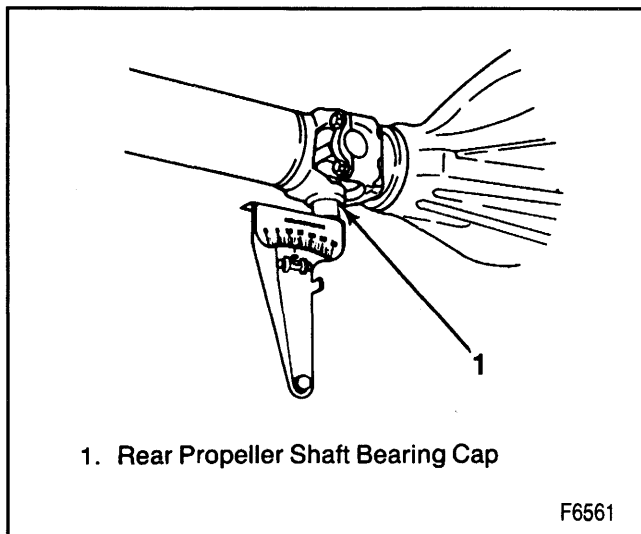


Figure 24—Measuring Rear U-Joint Working Angle

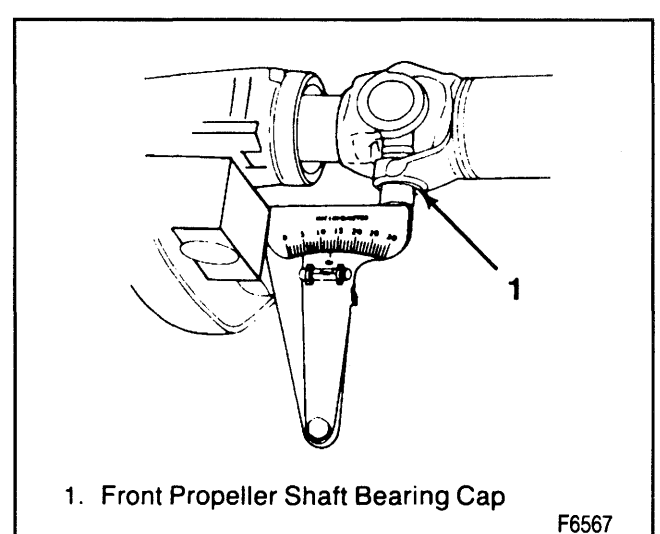


Figure 26—Measuring Front U-Joint Working Angle

ANGLE AT REAR UNIVERSAL JOINT

1. Place inclinometer J 23498-A on rear propeller shaft bearing cap (figure 24). Center the bubble in the sight glass and record the measurement. The bearing cap must be straight up and down and free of dirt or other foreign material to obtain an accurate measurement.
2. Rotate the propeller shaft 90 degrees and place the inclinometer on the rear drive yoke bearing cap (figure 25). Center the bubble in the sight glass and record the measurement.
3. Subtract the small figure from the larger figure to obtain the rear universal joint angle.

ANGLE AT FRONT UNIVERSAL JOINT

1. Place the inclinometer on front propeller shaft bearing cap (figure 26). Center the bubble in the sight and record measurement.
2. Rotate the propeller shaft 90 degrees and place the inclinometer on the front slip spline yoke bearing cap (figure 27). Center the bubble in the sight glass and record the measurement.
3. Subtract the smaller figure from the larger figure to obtain the front universal joint angle.

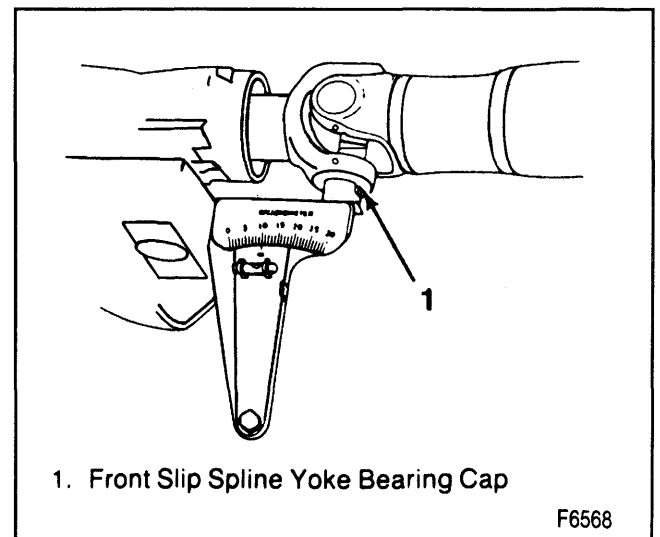


Figure 27—Measuring Front U-Joint Working Angle

OC-18 VIBRATION DIAGNOSIS

RULES FOR MEASURING DRIVELINE ANGLES

Rule Number 1 —The working angles of each pair of U-joints must be within one-half degree of being equal on shafts that turn at 3200 rpm or higher, or within one degree of being equal on shafts that turn at speeds below 3200 rpm.

Rule Number 2 —(Involves a two drive shaft, three U-joint system). With a three-joint system there is always an odd joint that cannot be paired with another joint. Since the U-joint between the transmission and the front shaft does not have a mate to cancel out its acceleration and deceleration, this front shaft should be within one-half degree of the transmission angle for high-speed shaft and within one degree for low-speed shafts. If the rear-end pinion angle is not equal to either the engine/transmission angle or front shaft angle, it should be at an angle between those two. There can be

a one-half degree difference between the center and rear U-joint working angles, provided neither of the working angles exceed 3 degrees on high-speed shafts (turning at 3200 rpm or higher), or 5 degrees on low-speed shafts (turning below 3200 rpm).

VIBRATION DIAGNOSIS CHARTS

Refer to figures 28 through 35.

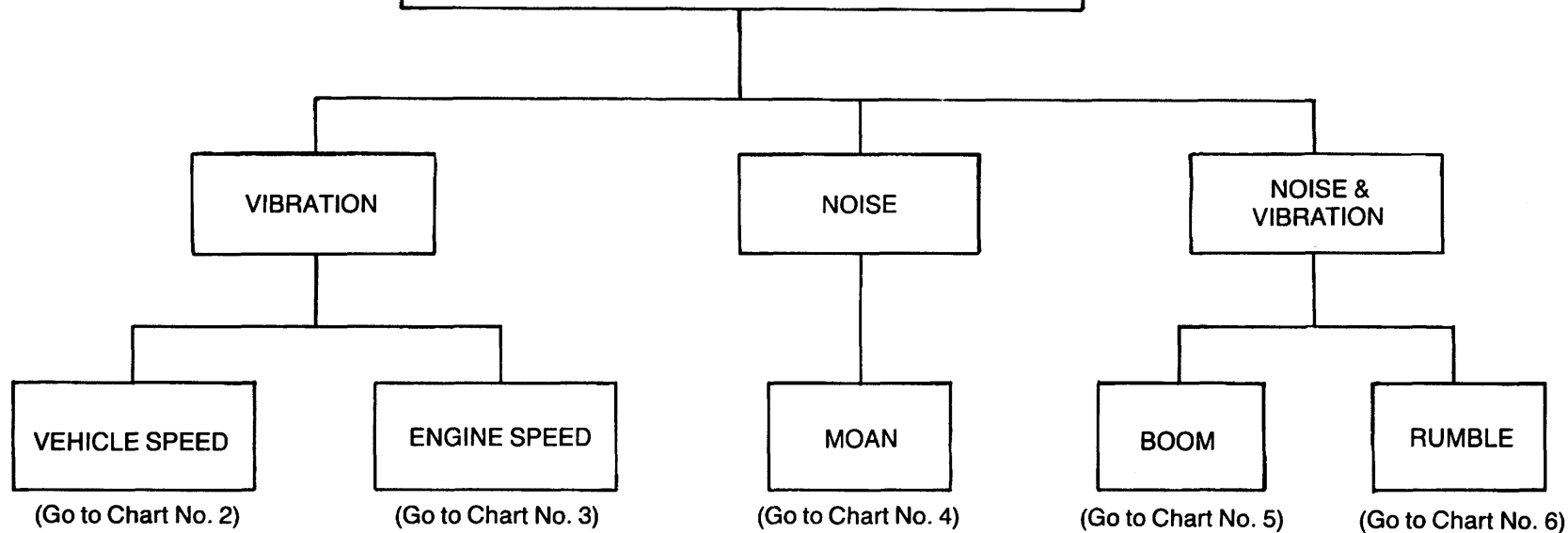
TECHNICIAN VIBRATION DIAGNOSIS FORM

The following form is for the technician to use when diagnosing a vibration problem. Copies of this form should be made for future use.

The form used for diagnosing a vibration problem is found after the vibration diagnosis charts. Copies of this form should be made for future use.

NOISE AND VIBRATION INDEX CHART

Ride vehicle (with customer if possible) to point out complaint. Check tire condition and pressures. Use "Reed" Tachometer to identify vibration frequency. Refer to "Reed Tachometer" in this section.



VEHICLE SPEED — Speedometer (vehicle speed) related.

ENGINE SPEED — Tachometer (engine speed) related.

MOAN — A low frequency noise which sounds like exhaust noise, is engine rpm and/or engine torque sensitive. Most customers will complain of noise — maybe a vibration or buzz in floor.

BOOM — A drum sound which occurs on impact with hole or seams in the road then dies out, could have a vibration along with the drumming sound.

RUMBLE* A steady drumming sound and vibration which is vehicle speed sensitive and continues as long as the vehicle speed is maintained, regardless of engine speed.

*NOTE: "Load sensitive rumble" — may only be noted with certain vehicle loads and speed conditions.

"Height (jounce) sensitive rumble" — Noise and vibration will vary in intensity and degree as vehicle height change takes place with road terrain change.

VIBRATION — Vehicle Speed Sensitive (Vibration Occurs at a Specific Vehicle Speed)

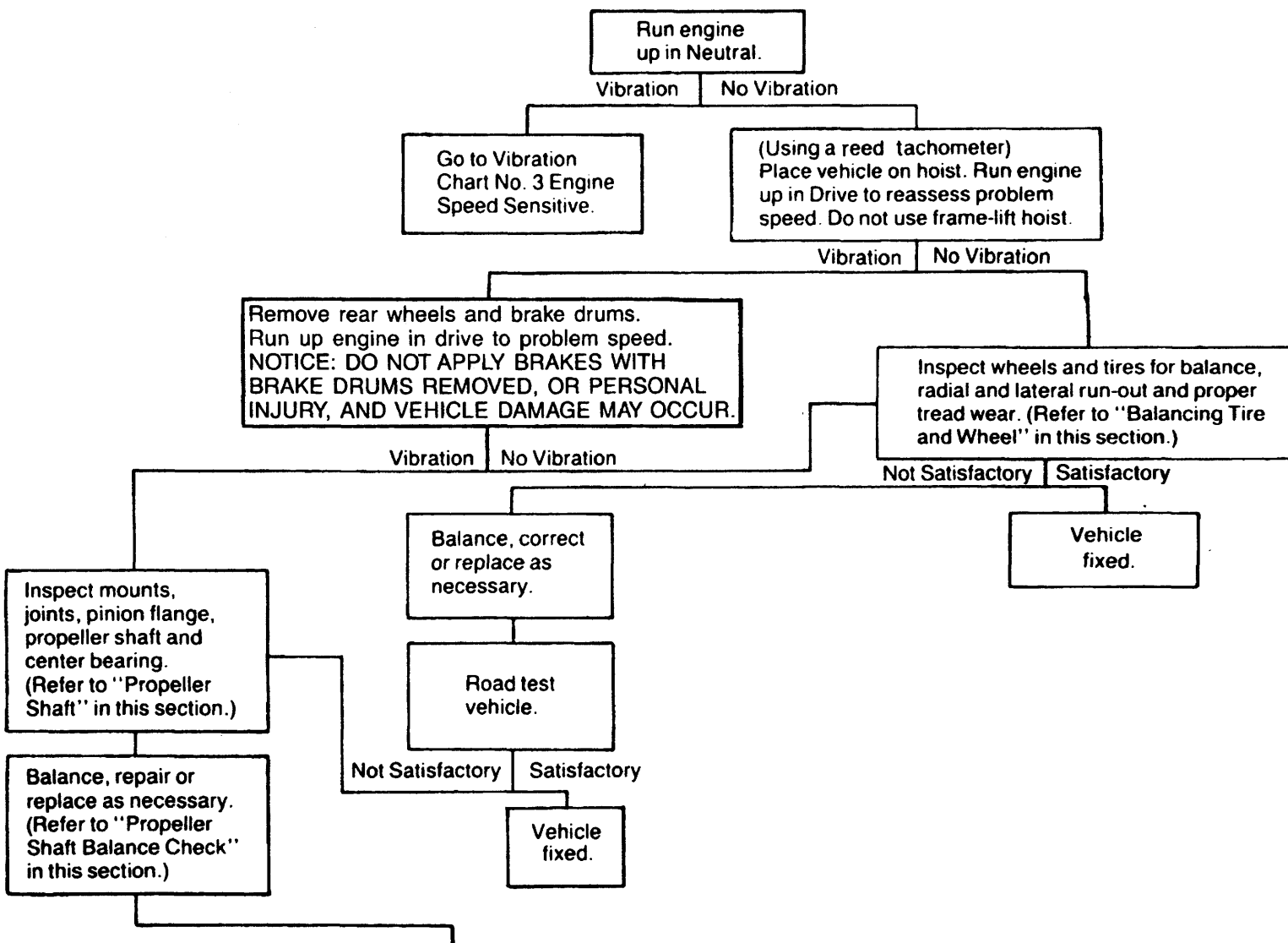


Figure 29—Vibration Diagnosis Chart #2

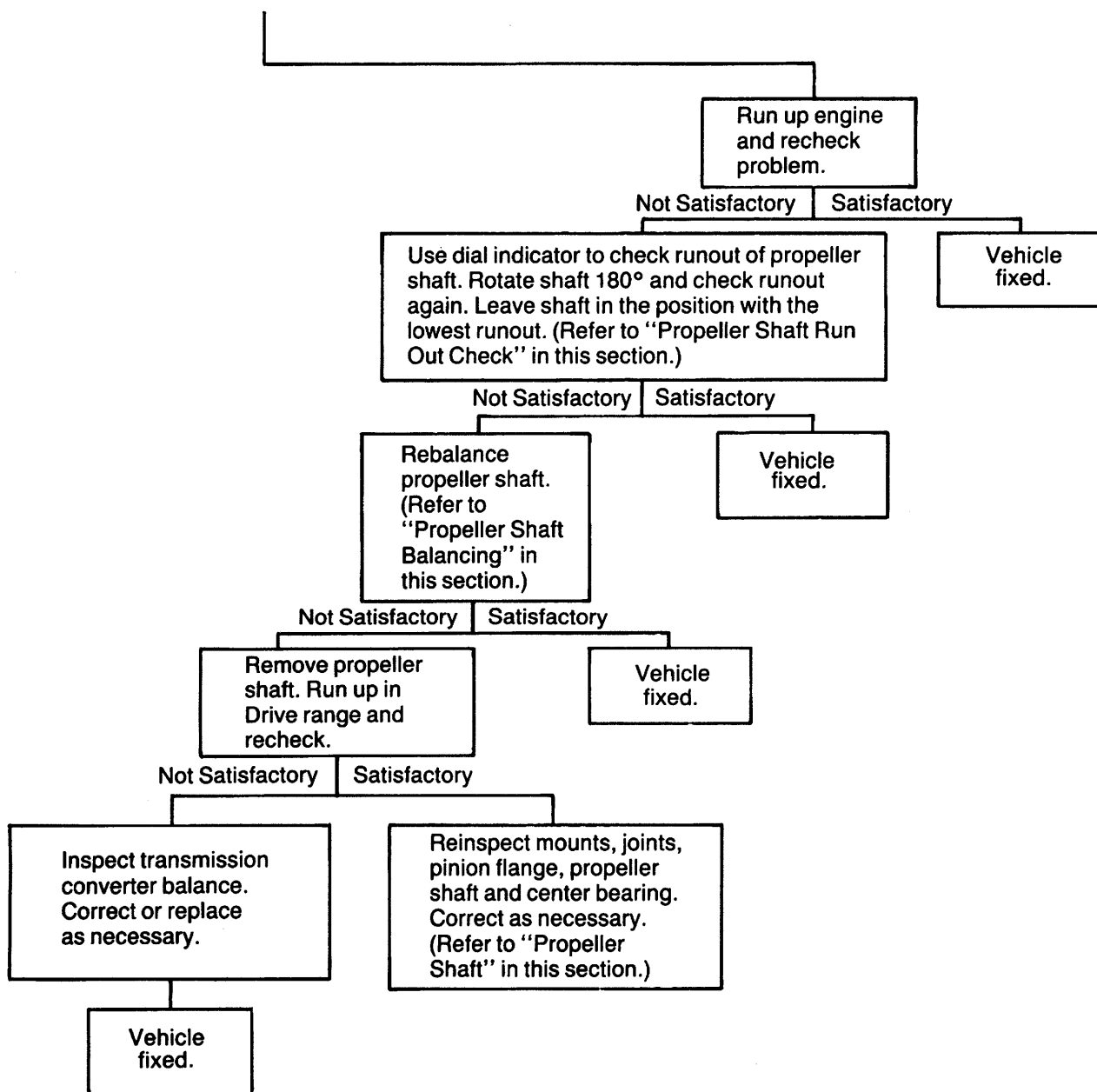


Figure 30—Vibration Diagnosis Chart #2 Continued

VIBRATION — Engine Speed Sensitive (A vibration occurring at a certain engine tachometer reading regardless of vehicle speed)

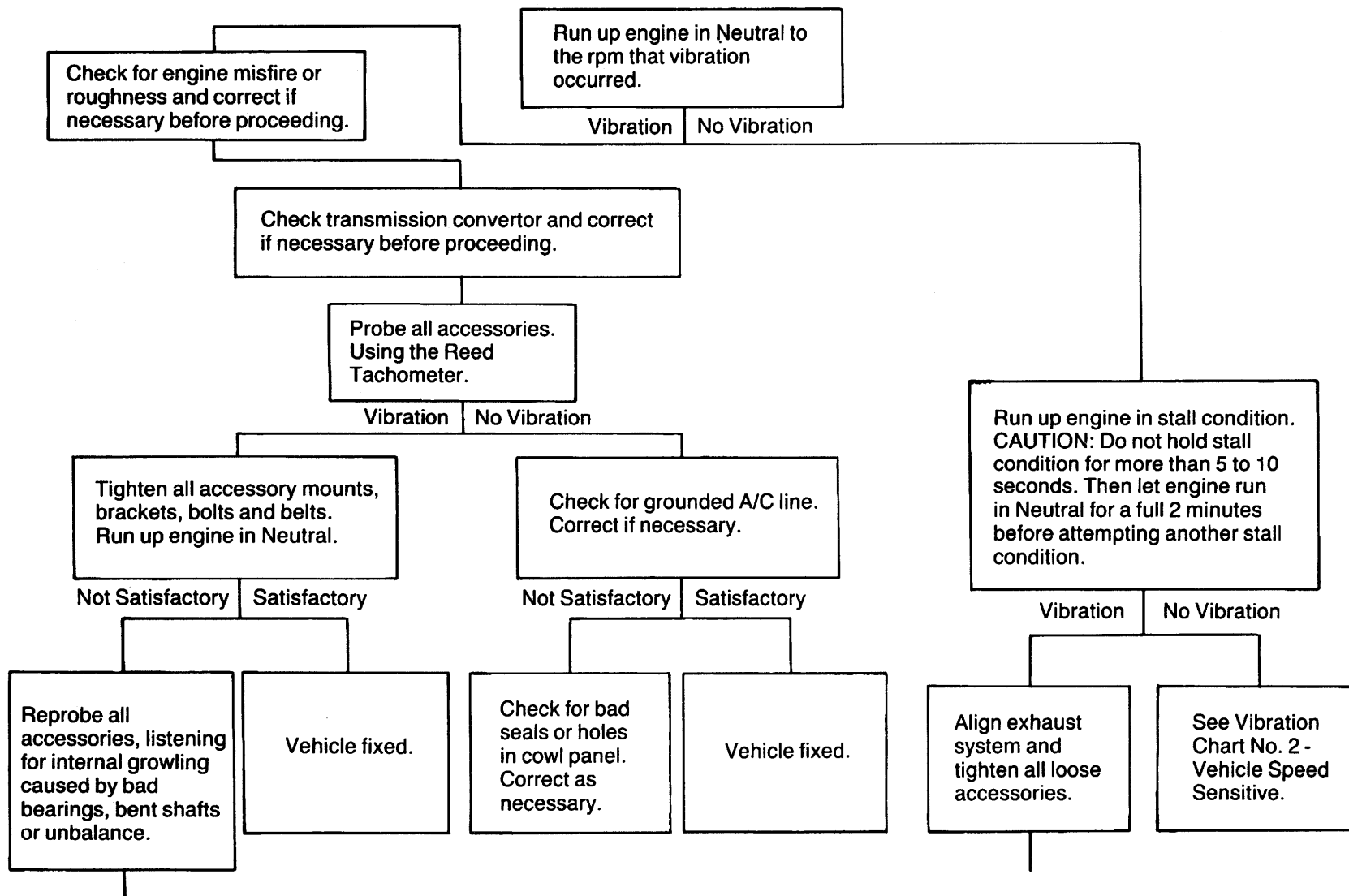


Figure 31—Vibration Diagnosis Chart #3

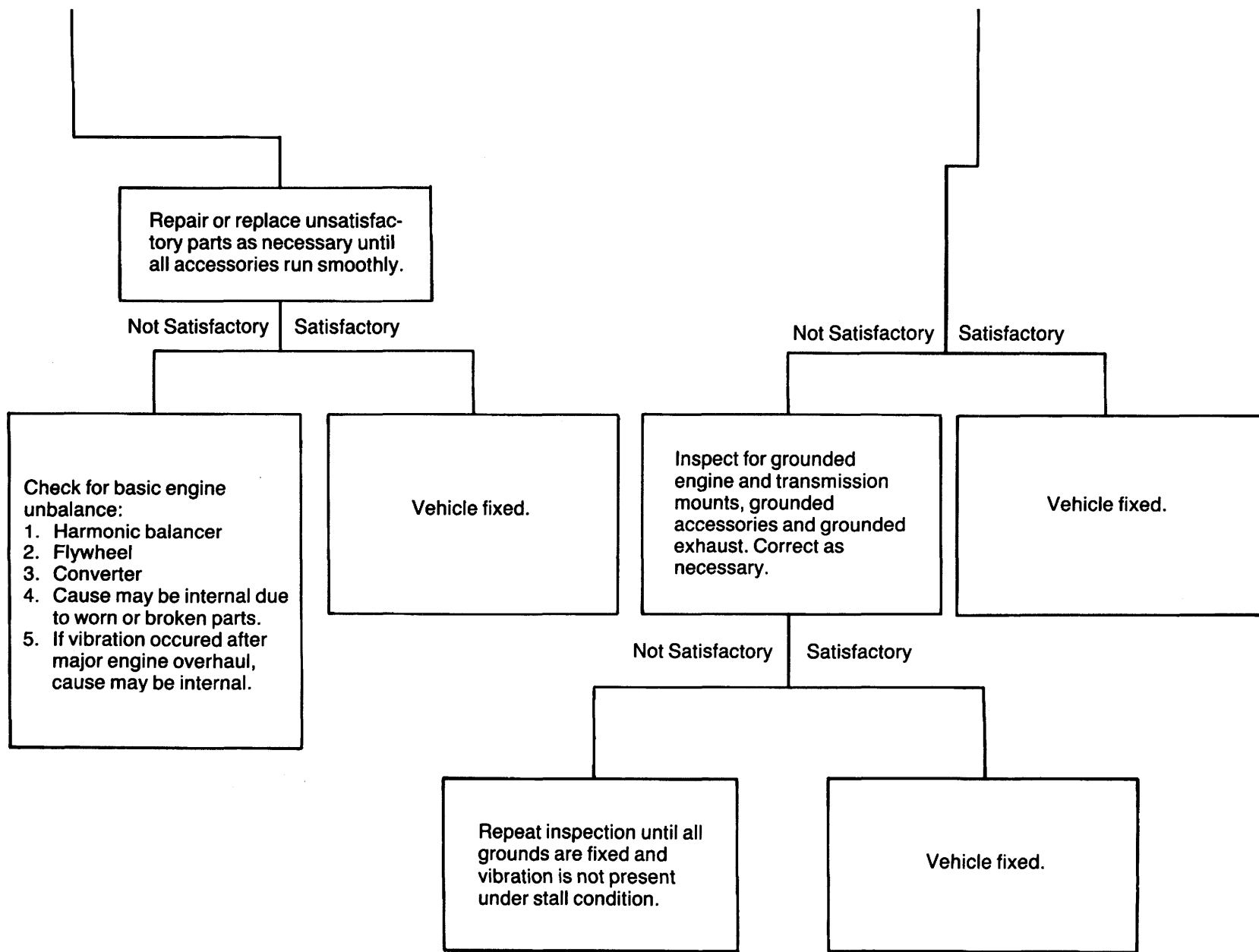


Figure 32—Vibration Diagnosis Chart #3 Continued

MOAN

(Low Frequency Noise Which Sounds Like Exhaust Noise, is Engine RPM and/or Engine Torque Sensitive — Sometimes Accompanied by Vibration or Buzz in Floor)

Visually and physically inspect and correct:

1. Loose air cleaner wing nut.
2. Loose accessory drive belts.
3. All accessory mounting brackets and bolts for tightness.
4. Grounded A/C lines.
5. Grounded engine and transmission mounts.
6. Grounded exhaust system.

BOOM — Noise and Vibration
(A drum sound which occurs on impact
with holes or seams in the road surface)

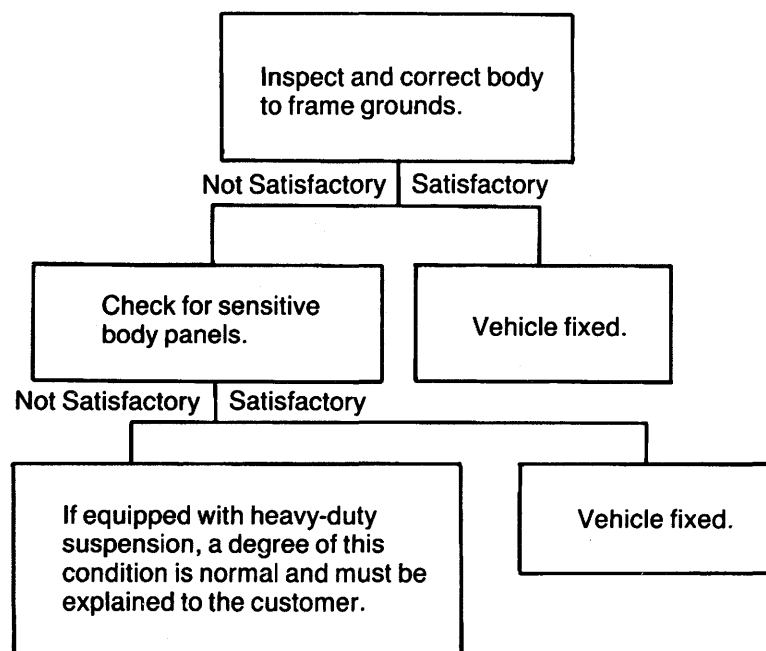
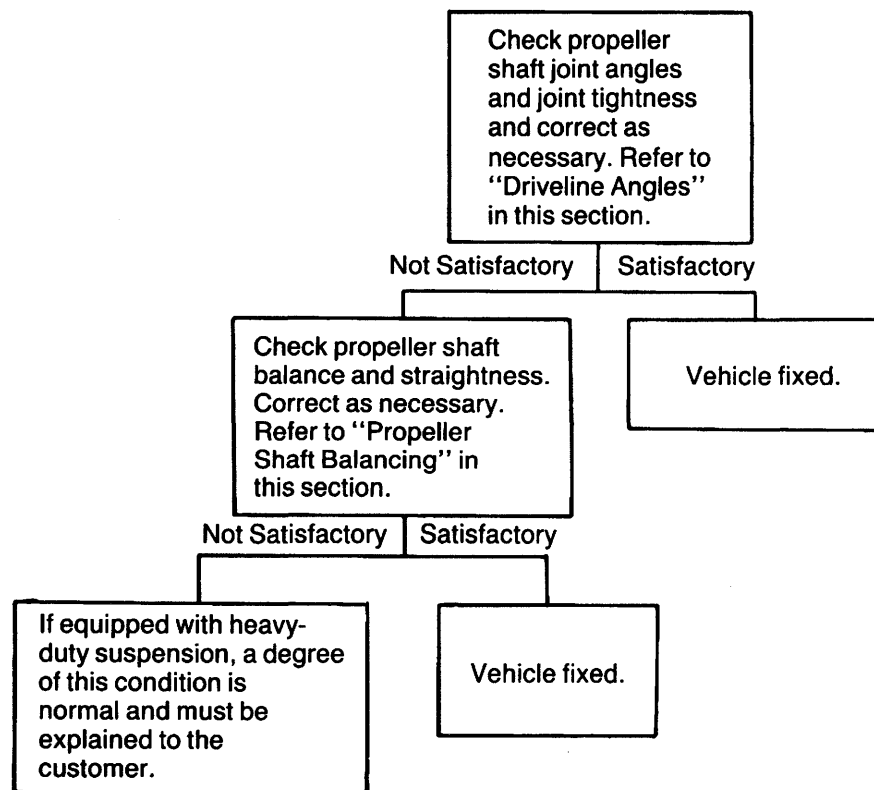


Figure 34—Vibration Diagnosis Chart #5

RUMBLE — Noise and Vibration (A steady drumming sound which is vehicle speed sensitive and continues as long as vehicle speed is maintained)



NOTE: Rumble may be vehicle load sensitive or vehicle height sensitive.
Refer to "Vibration Categories" in this section.

Figure 35—Vibration Diagnosis Chart #6

**TIRE/WHEEL AND PROPSHAFT ROTATION
FRONT ENGINE—REAR DRIVE**

Vehicle Information

Complaint Speed: _____ mph Year: _____ Model: _____
 Symptom: _____ VIN: _____
 Frequency: _____ Engine: _____ Trans: _____
 Engine Speed: _____ rpm Tire Size: _____ Axle Ratio: _____
 Gear: _____ TPC Spec: _____

Tire/Wheel Speed

Vibration Occurs at: mph ÷ 5 (mph) = increments of 5 mph

5 mph increments x tire RPS* at 5 mph (from chart) = **Tire/Wheel Speed, RPS (Hz) 1st order**

1st order x 2 = 2nd order

1st order x 3 = 3rd order

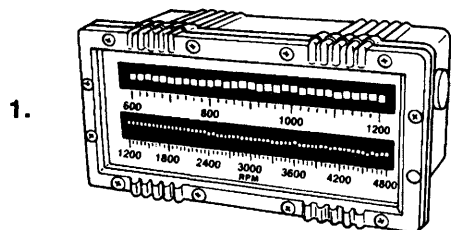
Propshaft Speed

1st order tire x (axle ratio) = **Propshaft Speed 1st order**

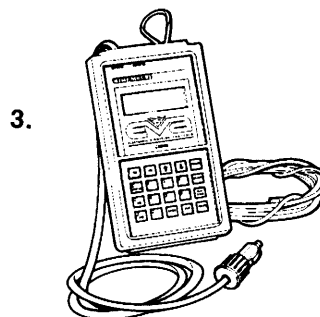
1st order propshaft x 2 = 2nd order

*RPS=revolutions per second; equates to cycles per second (Hz).

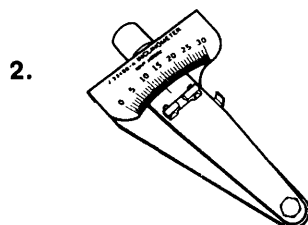
SPECIAL TOOLS



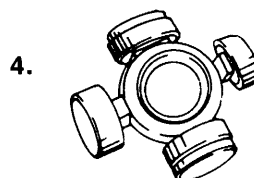
P/N 313510



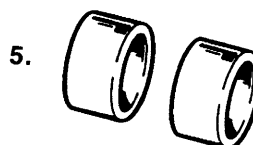
J 38792



J 23498-A



J 35819



J 35819-100

1. BIDDLE FHRAM REED TACHOMETER
2. INCLINOMETER
3. ELECTRONIC VIBRATION ANALYZER (EVA)
4. COMPANION FLANGE RUNOUT GAGE
5. RUNOUT GAGE ADAPTER SLEEVES

SECTION 1**HEATING AND AIR CONDITIONING****CONTENTS**

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Heater, Ventilation, and Air Conditioning	1B-1

SECTION 1A**HEATER AND VENTILATION**

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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1A-2 HEATER AND VENTILATION

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GENERAL DESCRIPTION

BASE HEATER SYSTEM

The heater system that is base equipment provides heating, ram air, power ventilation, and windshield defrosting. Outside air is drawn from the plenum at the base of the windshield into the heater module by the blower fan. Additional outside air, called ram air, is forced into the heater module by the forward movement of the vehicle. Within the heater module, the air is heated as required and then routed through ducts to the proper outlets for discharge into the passenger compartment. A control assembly in the instrument panel allows the operator to control blower speed, mode of operation and temperature of the air coming from the heater system.

CONTROLS

The control assembly in the instrument panel contains a blower switch, a mode lever, and a temperature lever. The controls are lit when the headlamps are on. Electrical power is provided by the instrument panel lighting circuit from the instrument panel harness.

Brightness of the dial illumination is controlled by the instrument panel dimmer control. The control assembly bulbs are in parallel with the radio bulb and instrument cluster illumination bulbs.

TEMPERATURE LEVER

The temperature lever operates the temperature control cable that goes to the heater module. When the temperature lever is in the “-” (Cold) or the left end of the slot, all of the air delivered by the heater system is unheated. When the temperature lever is in the “+” (Hot) or the right end of the slot, all of the air passing through the heater module is heated before it is discharged. Intermediate positions of the temperature lever result in a mixture of heated and unheated air to provide more moderate air temperatures.

MODE LEVER

The mode lever operates the defrost control cable that goes to the heater module. This cable operates a crank lever and shaft that controls the position of an air valve in the heater module. Mode lever positions are “Vent,” “Heater,” and “Defrost.”

BLOWER SPEED CONTROL

The blower switch provides a choice of various blower speeds. It receives power through a fuse in the fuse block when the ignition is “ON.” In the “Lo (-)” position, the circuit continues through the heater wiring harness to two resistors in the resistor assembly near the blower motor.

When the blower switch is in a medium-speed position, the circuit continues through the heater wiring harness to the resistor assembly, but it bypasses one of the two resistors.

When the blower switch is in the "Hi (+)" position, the circuit continues through the heater wiring harness to the resistor assembly, but it bypasses both resistors to provide full power to the blower motor.

From the resistor assembly, the circuit goes to the blower motor terminal to operate the blower motor. The blower motor circuit is completed to ground by a wire in the heater wiring harness that goes from the blower motor terminal to a terminal at the dash panel sheet metal near the blower assembly in the engine compartment.

AIR DISTRIBUTION SYSTEM

Within the heater module is a series of air valves called the temperature valve, vent valve, and the defroster valve. These air valves are hinged parts that act like doors to direct the airflow through various sections of the heater module to provide the proper airflow for the selected operating mode. Each air valve is controlled by a control cable from the heater control assembly.

TEMPERATURE VALVE AND HEATER CORE

The temperature of the air coming from the heater duct and defroster nozzle is regulated by controlling the relative amounts of warm and cool air in the airflow coming from the heater module. The part of the total airflow through the heater module that is allowed to pass through the heater core is governed by the temperature valve. The temperature valve is operated by the temperature control cable, working through a lever on the temperature valve shaft.

When the temperature lever in the control assembly is in the extreme left end of its slot, or the full "-" (Cold) position, the temperature valve is positioned to stop all of the airflow through the heater core so only unheated air is sent to the heater duct and defroster nozzle.

As the temperature lever is moved away from the full "-" (Cold) position, the temperature control cable opens the temperature valve to allow an increasing amount of air to pass through the heater core. At the same time, the temperature valve reduces the amount of unheated air that is allowed to enter the mixture. This results in a very responsive control of the temperature of the air discharged through the heater ducts and defroster nozzle.

When the temperature lever reaches the full "+" (Hot) position at the extreme right end of its slot, the temperature control cable holds the temperature valve in a position that diverts all of the airflow through the heater core for maximum heating.

Hot coolant from the engine is directed through the heater core and returned to the cooling system when the engine is running.

MODE VALVES

The heater system provides a choice of three basic operating modes consisting of "Vent," "Heater," and "Defrost."

OPERATING MODES

VENT MODE

When the mode lever is in the "Vent" position or the extreme left end of the slot, the defroster valve and heater valve remains closed. As a result, air coming from the instrument panel vents should be nearly the same temperature as the outside air.

HEATER MODE

When the mode lever is in the "Heater" position or the center of the slot, the defroster valve remains closed. As a result, air from the blower fan is heated as necessary and directed to the defroster valve which sends most of the airflow to the heater duct, with some going to the defroster nozzle.

DEFROST MODE

When the mode lever is in the "Defrost" position or the extreme right end of the slot, the defroster control cable moves the defroster valve to fully uncover the opening to the defroster nozzle and restrict the opening to the heater duct. This delivers the maximum airflow to the defroster nozzle, with only a small amount of airflow coming out of the heater duct.

VENTILATION

Two push-pull controls under the steering column operate vent cables to the left and right air vents in the heater module that admit ram air to the vehicle interior. The left and right air vents discharge air directly to the floor area by the heater module. Because the air is taken directly from the plenum, bypassing the heater core as well as the blower fan, it is always delivered at the temperature of the outside air.

AUXILIARY HEATER

An auxiliary heater provides additional heating capacity for the rear of the Suburban model.

This unit operates independently of the standard heater, and is regulated through its own controls in the instrument panel (Aux. Heater Models) or roof panel (Aux. Heater and A/C Models). This system consists of a separate core and fan unit mounted in the rear of the vehicle.

CONTROLS

Blower Switch

The auxiliary heater blower switch is located in the instrument panel to the right of the steering column (Aux. Heater Models) or the roof panel (Aux. Heater and A/C Models).

DIAGNOSIS

FUNCTIONAL TEST

Before beginning the functional test of the heater system, the vehicle should be idling with the coolant hot and the thermostat open. Coolant temperature should be close to 90°C (194°F). During the functional test, the operating efforts of the mode lever and the temperature lever should be evaluated. Even if a problem is found during any intermediate step of the functional test, the test should be completed before repair is started (figure 1).

1. Cycle the temperature lever to the extreme ends of travel in the slot of the control assembly dial to assure that the cable is properly adjusted.
2. Move the mode lever to the "Vent" position.
 - Air at nearly the same temperature as the outside air should come from the instrument panel outlets.
 - Air should not come from the floor outlets, the defroster nozzles, or the side window defogger outlets.
3. Move the mode lever to the "Heater" position.
 - Most of the air should come from the floor outlets with the remainder coming out of the defroster nozzles and defogger outlets.
 - Air should not come from the instrument panel outlets in the "Heater" position.

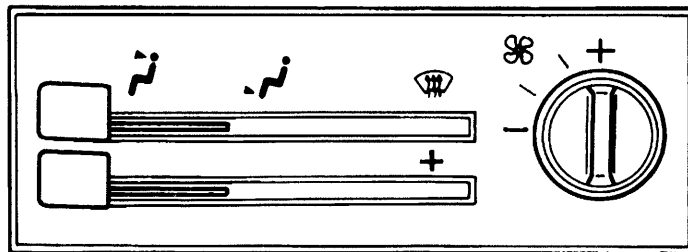
4. Move the mode lever from the "Heater" position to the "Defrost" position.
 - Most of the air should be discharged onto the windshield from the defroster nozzles.
 - A small amount of air should also be discharged from the floor outlets.
5. Move the temperature lever back to the full "-" (Cold) position and check to be sure the air temperature drops back to nearly the temperature of the outside air once again.
6. Slowly turn the blower switch toward "-" stopping briefly at each intermediate blower speed position to notice the force of the airflow coming from the instrument panel center outlets and the sound of the blower.
 - Both the airflow and the blower noise should reduce noticeably at each intermediate step.

HEATER OUTPUT TEMPERATURE CHECK

The heat output of the heater system can be checked with the following procedure.

Preparation

With the engine sufficiently cool, the radiator cap should be removed and the engine started and allowed to idle. Heater controls should be set to "Heater" mode,



HEATER CONTROL ASSEMBLY

FAN SWITCH				
Term	POSITION			
	Off	M ₁	M ₂	HI
B +	Continuity to LO	Continuity to M ₁	Continuity to M ₂	Continuity to HI
HI	No Continuity	No Continuity	No Continuity	Continuity to B +
LO	No Continuity	Continuity to B +	No Continuity	No Continuity
MED	No Continuity	No Continuity	Continuity to B +	No Continuity
OFF	Continuity to B +	No Continuity	No Continuity	No Continuity

F9613

Figure 1—Control Assembly Functional Test

full "+" (Hot) temperature and "Hi (+)" blower speed. When coolant flow in the radiator is visible through the filler neck, the radiator cap should be installed.

Temperature Check

When the engine is warmed up (after approximately 20 minutes of operation), the vehicle should be driven. An accurate thermometer should be used to determine the temperature of the outside air and the temperature of the air discharged at the floor outlets with the vehicle being driven at 48 km/h (30 mph). Minimum acceptable heater output temperatures at four different outside air temperatures are shown in the table below.

Outside Air Temperature	-18°C (0°F)	-4°C (25°F)	10°C (50°F)	24°C (75°F)
Heater Air Temperature	54°C (130°F)	59°C (139°F)	64°C (147°F)	68°C (155°F)
T2550				

Minimum acceptable heater output temperatures for outside air temperatures other than those shown can be approximated by using the Fahrenheit scale and rounding off the outside air temperature to the nearest 5 degrees. For every additional 5 degrees of outside temperature, an additional 1.8 degrees of heater output temperature should be allowed when the outside temperature is below 50 degrees. An additional 1.6 degrees of heater output temperature should be allowed for every 5 degrees of outside temperature when the outside temperature is above 50 degrees.

INSUFFICIENT HEATING OR DEFROSTING

The most likely causes of insufficient heating outside the heater system include a low coolant level, a faulty thermostat, a partially or fully clogged heater core or hose, an obstruction to air circulation or an air leak past a faulty seal into the passenger compartment. For an organized diagnosis procedure, refer to figures 2 and 3.

IMPROPER AIR DELIVERY

If the "Functional Test" or other diagnosis indicates improper air delivery or a failure to shift modes when the mode lever is moved, check the attachment of the affected control cable at the heater module. Be sure the cable loop is connected to the crank pin and the cable sheath is retained.

If the cause of the problem is not discovered, disconnect the control cable at the crank pin and check the air control valve travel and effort. If there is proper valve travel and effort, check the control cable travel at the heater module end while moving the mode lever. If the cable end doesn't move, check for a broken cable or control assembly part and for an unattached cable end at the control assembly. Also, check for a sharp kink in the control cable sheath that could cause severe binding.

HIGH OR LOW TEMPERATURE CONTROL EFFORT

A kinked control cable, a binding valve or a faulty control assembly are possible causes of excessive temperature control lever effort. For an organized diagnosis procedure and an effective "fix" for too little temperature control effort, refer to figure 4.

BLOWER NOISE

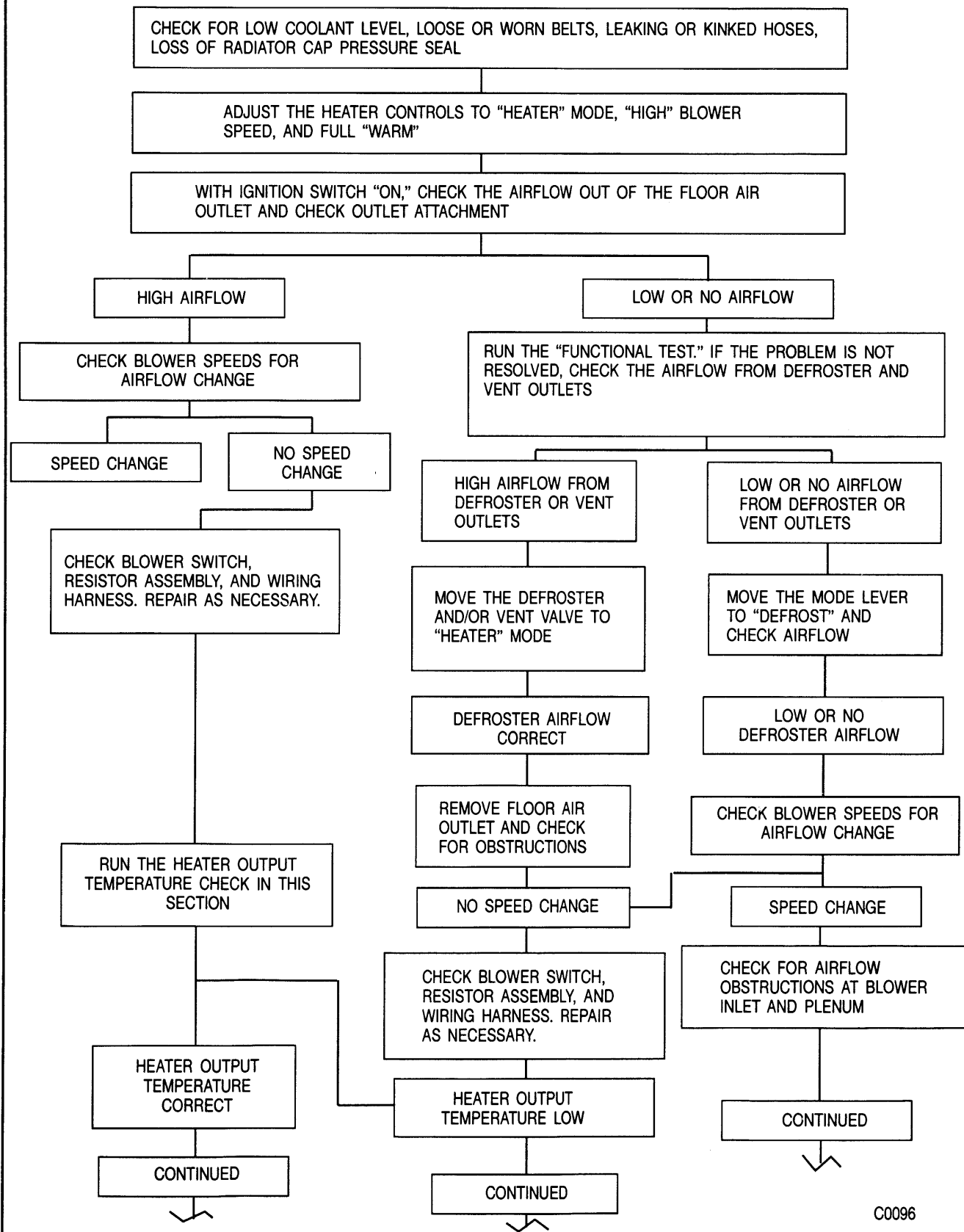
A constant air rush noise is typical of all heater systems, some may be louder than others. If possible, check a similar vehicle to determine whether the noise is typical or excessive. For diagnosis of excessive blower noise, refer to figures 5 and 6.

EXCESSIVE HEAT

The most likely cause of excessive heat from the heater system is an out-of-adjustment temperature control cable. Other related causes of excessive heat include a slipping self-adjusting clip at the temperature control cable end, a loose control cable sheath retainer or bracket at the bottom of the heater assembly, or a binding or obstructed temperature air valve. A hot air leak from the engine compartment to the blower inlet is also a remote possibility.

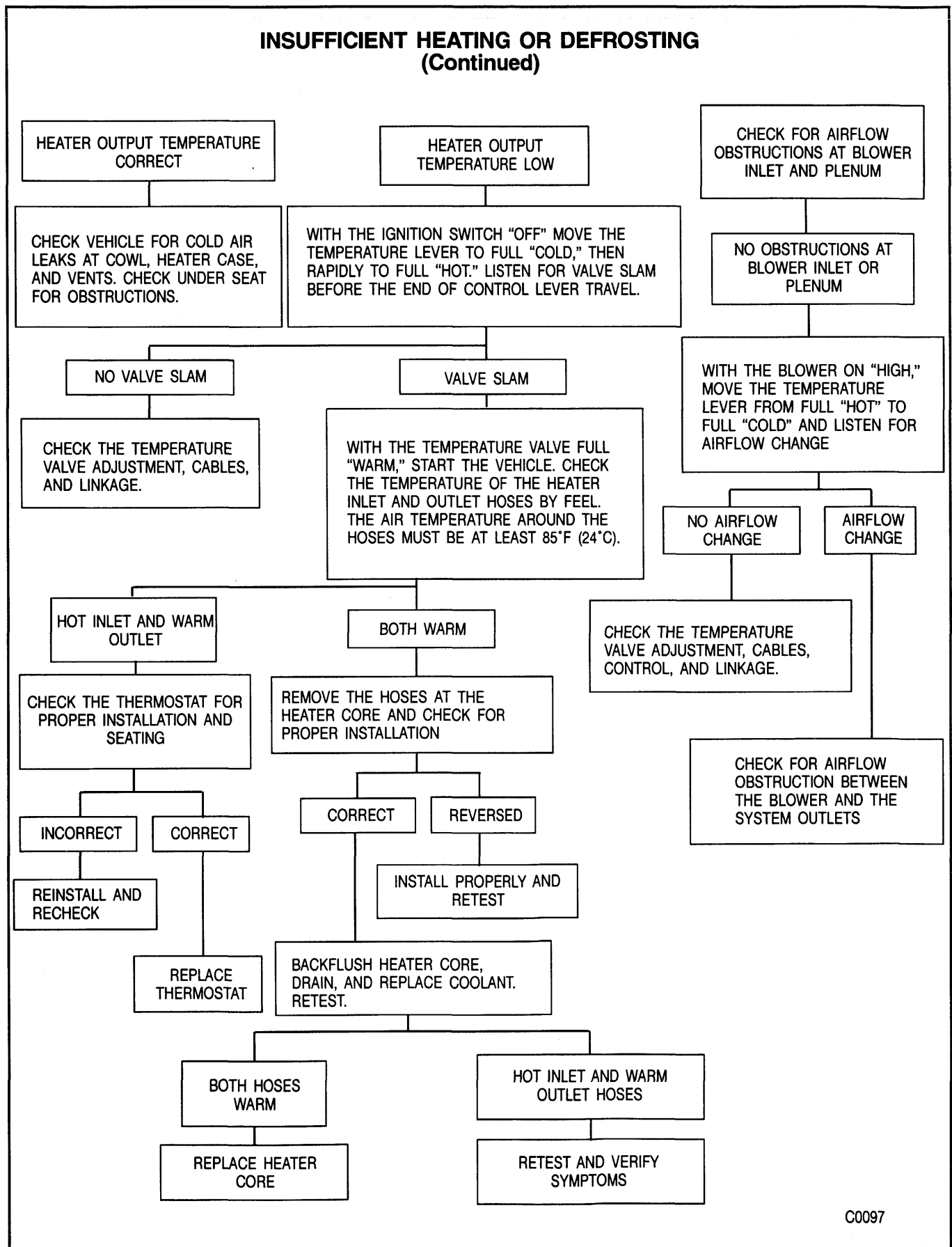
1A-6 HEATER AND VENTILATION

INSUFFICIENT HEATING OR DEFROSTING



C0096

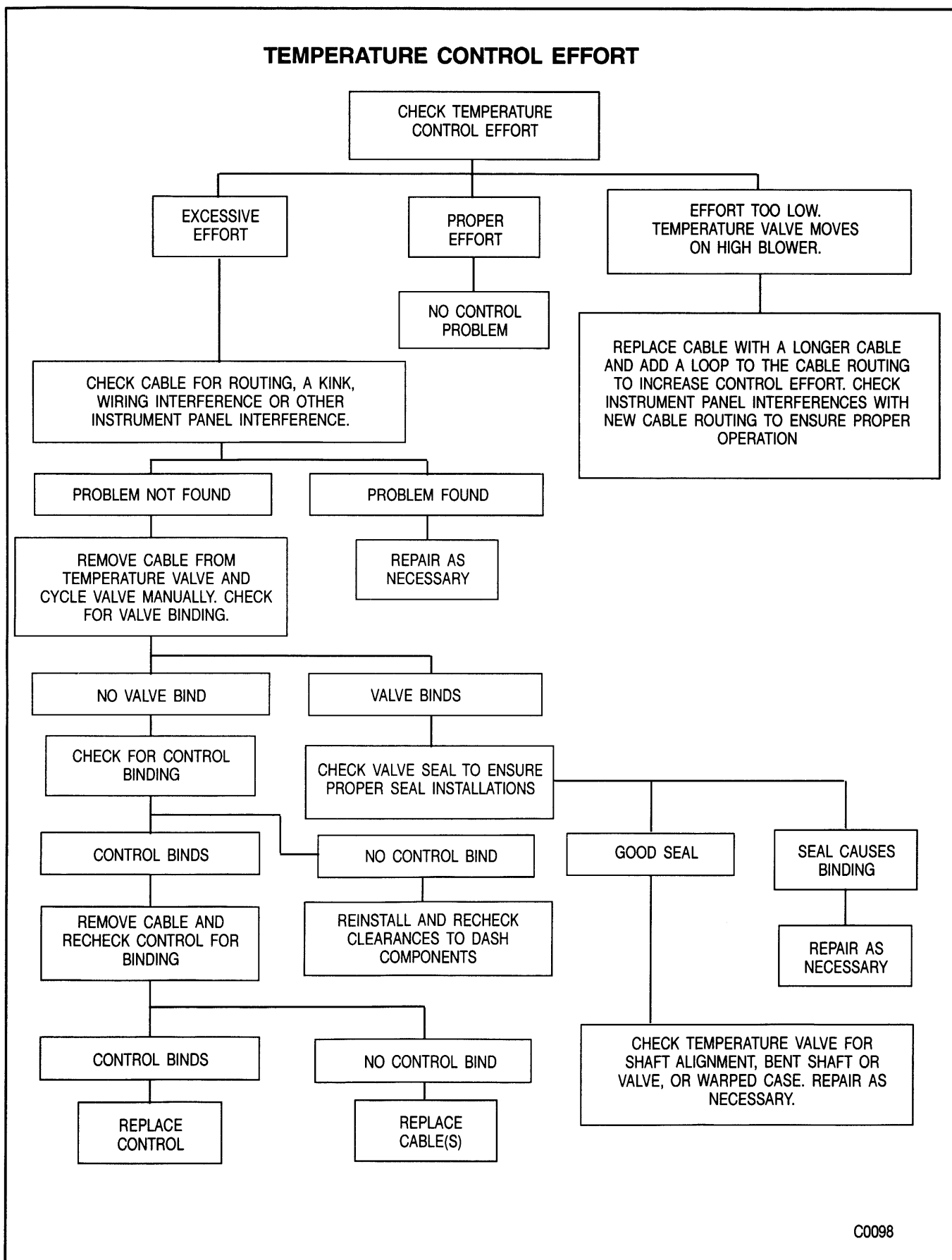
Figure 2—Insufficient Heating or Defrosting (1 of 2)



C0097

Figure 3—Insufficient Heating or Defrosting (2 of 2)

1A-8 HEATER AND VENTILATION



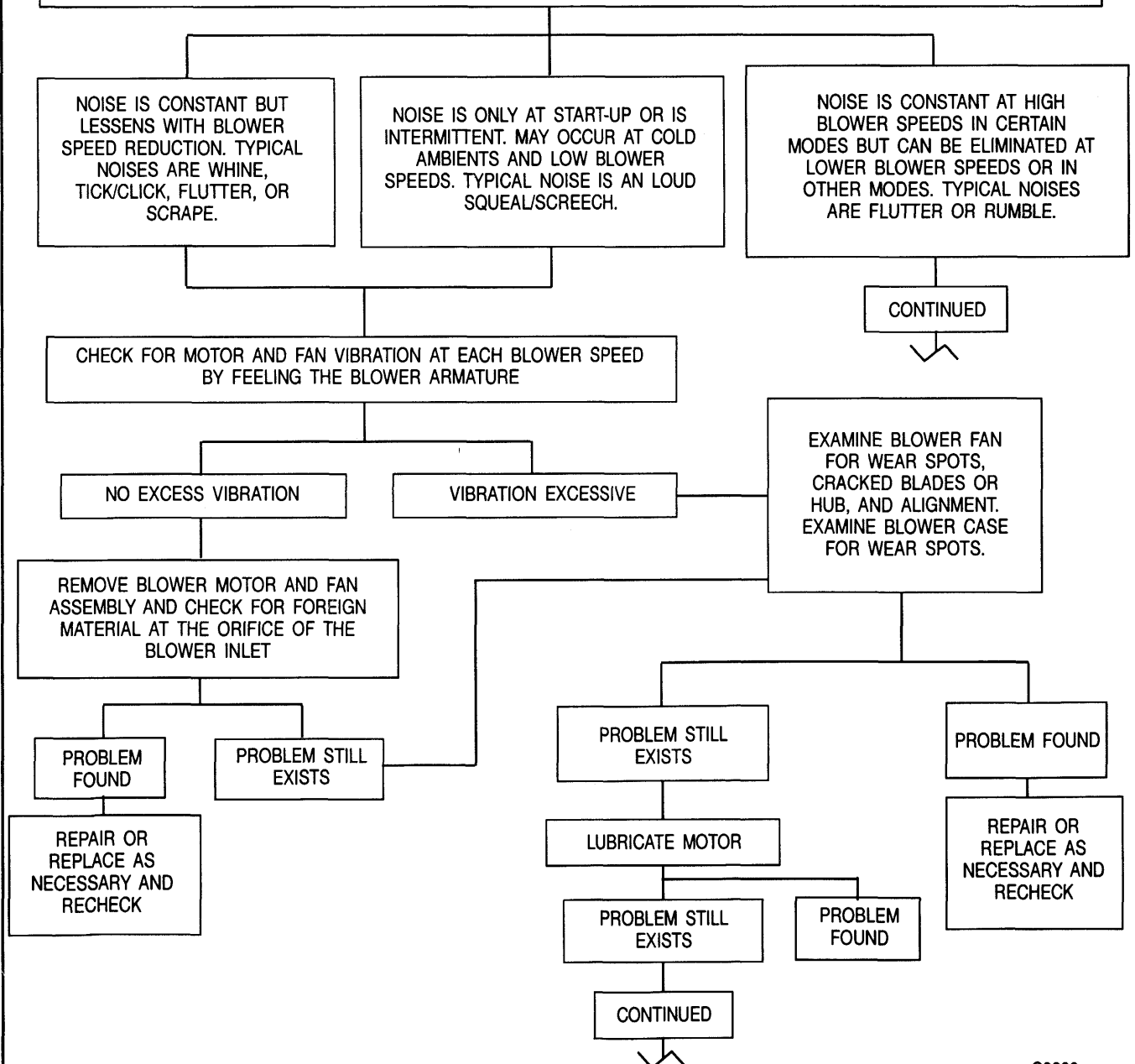
C0098

Figure 4—Temperature Control Effort Diagnosis Procedure

BLOWER NOISE

CHECK ALL ELECTRICAL CONNECTIONS AND GROUNDS FOR PROPER CONNECTIONS. IF IN DOUBT, USE A VOLTMETER TO CHECK FOR CONSTANT VOLTAGE AT THE BLOWER MOTOR.

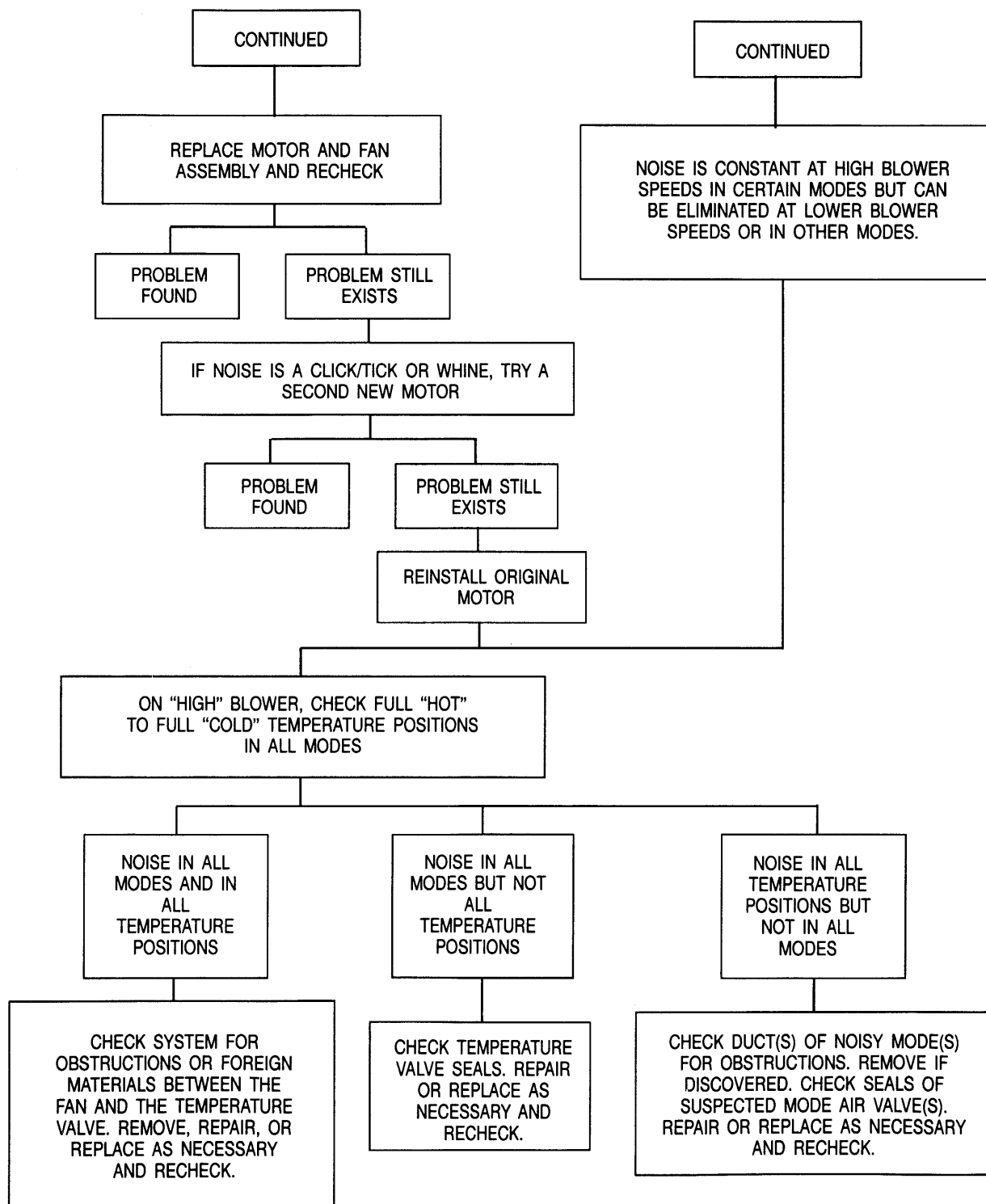
SIT IN THE VEHICLE WITH THE DOORS AND WINDOWS CLOSED. WITH THE IGNITION SWITCH "ON" AND THE ENGINE OFF, START THE BLOWER ON "HIGH" AND THE TEMPERATURE LEVER ON FULL "COLD." CYCLE THROUGH BLOWER SPEEDS, MODES AND TEMPERATURE VALVE POSITIONS TO FIND WHERE THE NOISE OCCURS AND WHERE THE NOISE DOES NOT OCCUR. TRY TO DEFINE THE TYPE OF NOISE: AIR RUSH, WHINE, TICK/CLICK, SQUEAL/SCREECH, FLUTTER, RUMBLE, OR SCRAPE. CHECK ANOTHER VEHICLE IF POSSIBLE (SAME MODEL) TO DETERMINE IF THE NOISE IS TYPICAL.



C0099

Figure 5—Blower Noise Diagnosis Procedure (1 of 2)

BLOWER NOISE (Continued)



C0100

Figure 6—Blower Noise Diagnosis Procedure (2 of 2)

ON-VEHICLE SERVICE

CONTROL ASSEMBLY AND BLOWER SWITCH

Remove or Disconnect (Figure 7)

1. Instrument panel bezel. Refer to SECTION 8C.
2. Screws (2).
3. Heater control assembly (1) from instrument panel.
4. Electrical connectors, as necessary.
5. Temperature control cable. Refer to "Temperature Control Cable."
6. Defrost control cable. Refer to "Defrost Control Cable."
7. Blower switch.

- Remove the blower switch knob and the retaining clip from the shaft of the blower switch.

Install or Connect (Figure 7)

1. Blower switch.
 - Hold the blower switch in position and install the retaining clip.
 - Install the blower switch knob.
2. Defrost control cable. Refer to "Defrost Control Cable."
3. Temperature control cable. Refer to "Temperature Control Cable."
4. Electrical connectors, as necessary.
5. Heater control assembly (1) to instrument panel.

NOTICE: Refer to "Notice" on page 1A-1.

6. Screws (2).

Tighten

- Screws (2) to 1.6 N.m (14 lbs. in.).
7. Instrument panel bezel. Refer to SECTION 8C.
 - Check circuit operation.

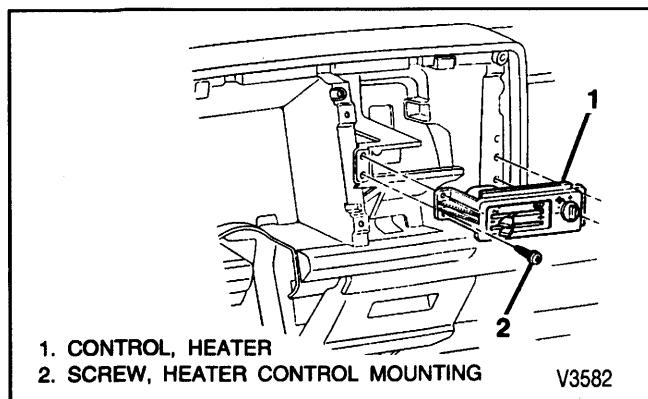


Figure 7—Heater Control Assembly

CONTROL ASSEMBLY LAMP BULB

Remove or Disconnect

1. Heater control assembly. Refer to "Control Assembly and Blower Switch."
 - Pull the heater control assembly out far enough to reach the control assembly lamp socket.
2. Bulb and socket.
3. Bulb from socket.
 - Pull the bulb straight out from the socket.

Inspect

- Control assembly lamp socket for corrosion and damage. Clean or replace as necessary.
- Wires for damage and secure connection to the bulb socket. Repair or replace as necessary.

Install or Connect

1. New bulb.
 - Push the bulb straight into the socket.
2. Bulb and socket.
3. Heater control assembly. Refer to "Control Assembly and Blower Switch."
 - Check circuit operation.

TEMPERATURE CONTROL CABLE

Remove or Disconnect (Figure 8)

1. Instrument panel trim plate. Refer to SECTION 10A4.
2. Heater control assembly (1). Refer to "Control Assembly and Blower Switch."
3. Electrical connectors, as necessary.
4. Nuts (5).
5. Temperature cable (4) from the heater control assembly (1).
6. Instrument panel compartment. Refer to SECTION 10A4.
7. Temperature cable (4) from the heater case.

Install or Connect (Figure 8)

1. Temperature cable (4) to the heater case.
2. Temperature cable (4) to the heater control assembly (1).
 - Route the cable in the same location as removed.
3. Nuts (5).
4. Instrument panel compartment. Refer to SECTION 10A4.
5. Electrical connectors, as necessary.
6. Heater control assembly (1). Refer to "Control Assembly and Blower Switch."
7. Instrument panel trim plate. Refer to SECTION 10A4.

1A-12 HEATER AND VENTILATION

DEFROST CONTROL CABLE

↔ Remove or Disconnect (Figure 8)

1. Instrument panel trim plate. Refer to SECTION 10A4.
2. Heater control assembly (1). Refer to "Control Assembly and Blower Switch."
3. Electrical connectors, as necessary.
4. Nuts (5).
5. Defrost cable (3) from the heater control assembly (1).
6. Instrument panel compartment. Refer to SECTION 10A4.
7. Defrost cable (3) from the heater case.

↔ Install or Connect (Figure 8)

1. Defrost cable (3) to the heater case.
2. Defrost cable (3) to the heater control assembly (1).
 - Route the cable in the same location as removed.
3. Nuts (5).
4. Instrument panel compartment. Refer to SECTION 10A4.
5. Electrical connectors, as necessary.
6. Heater control assembly (1). Refer to "Control Assembly and Blower Switch."
7. Instrument panel trim plate. Refer to SECTION 10A4.

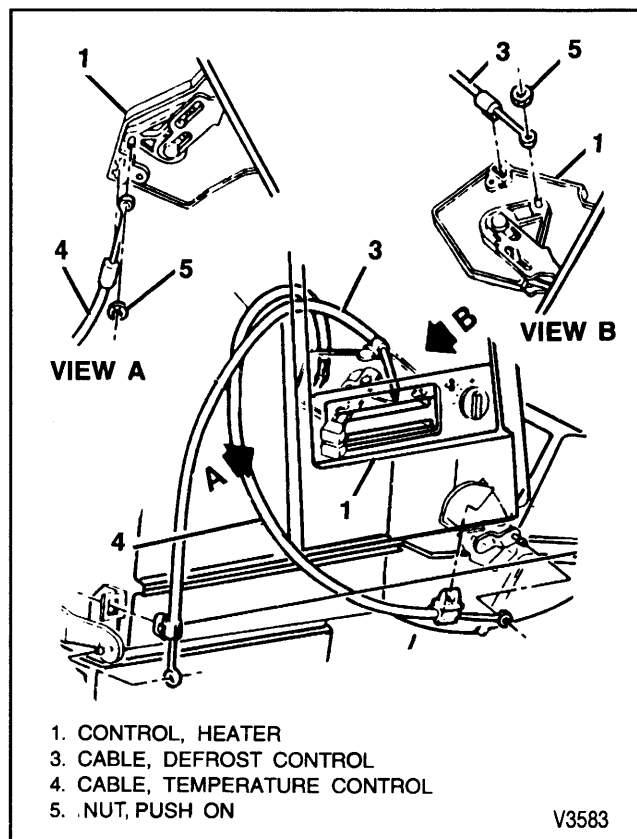


Figure 8—Temperature and Defrost Control Cable

NOTICE: Refer to "Notice" on page 1A-1.

2. Screw (8) to instrument panel (7).



Tighten

- Screw (8) to 1.9 N·m (17 lbs. in.).

3. Left vent cable. Refer to "Vent Control Cables."

AIR INLET VALVE

↔ Remove or Disconnect (Figure 9)

1. Left vent cable. Refer to "Vent Control Cables."
2. Screw (8) from instrument panel (7).
3. Air inlet valve (6) from deflector (9).

↔ Install or Connect (Figure 9)

1. Air inlet valve (21) to deflector (9).

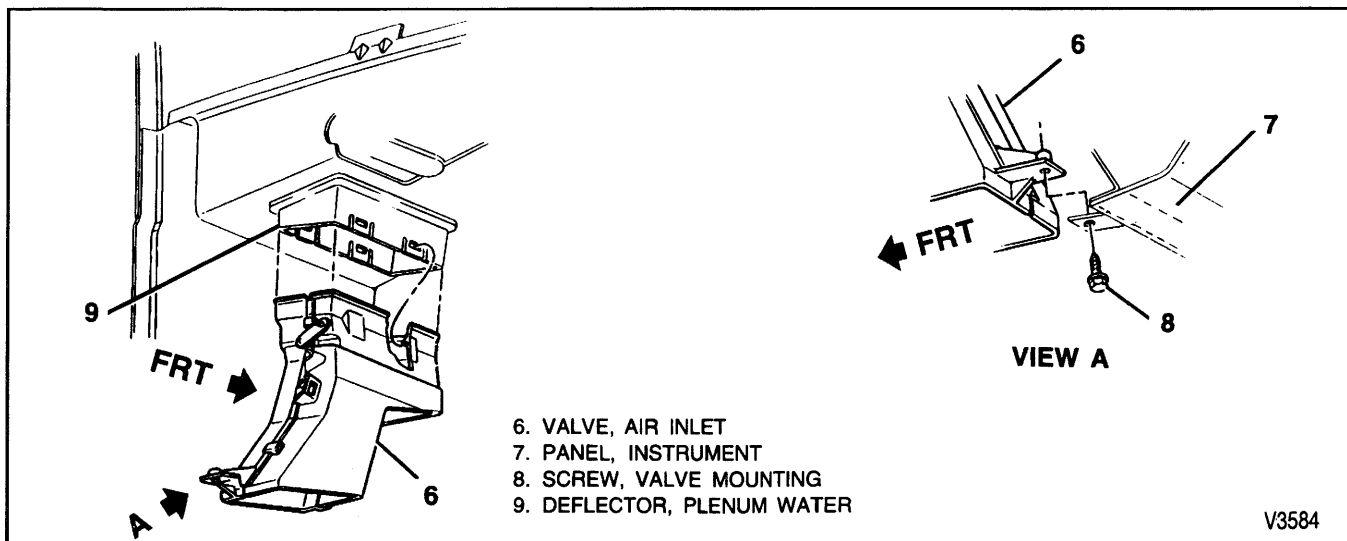


Figure 9—Air Inlet Valve

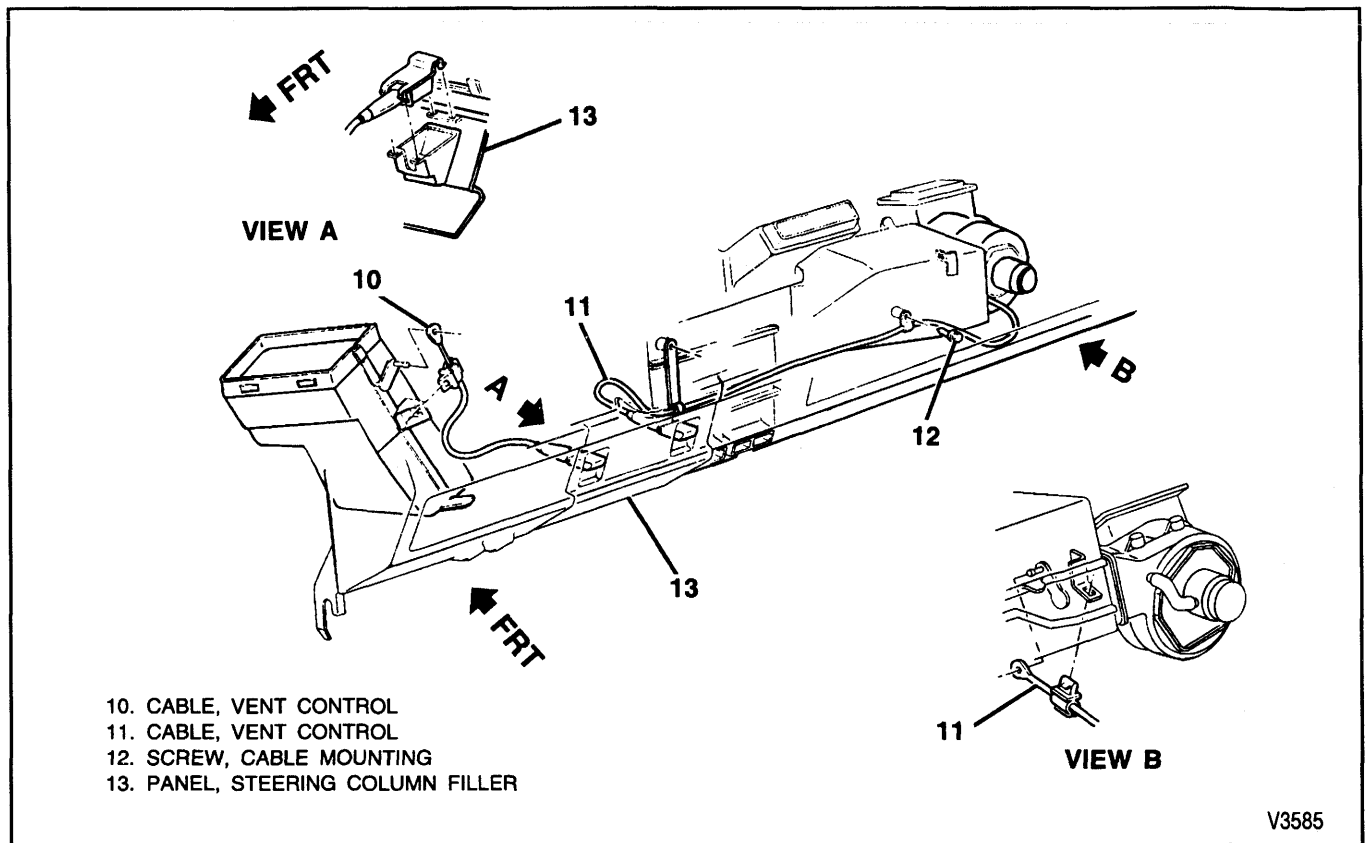


Figure 10—Vent Control Cable

VENT CONTROL CABLES

LEFT VENT CABLE

↔ Remove or Disconnect (Figure 10)

1. Steering column filler panel (13). Refer to SECTION 10A4.
2. Cable (10) from steering column filler panel (13).
3. Cable (10) from air inlet valve.

↔ Install or Connect (Figure 10)

1. Cable (10) to air inlet valve.
2. Cable (10) to steering column filler panel (13).
3. Steering column filler panel (13). Refer to SECTION 10A4.

RIGHT VENT CABLE

↔ Remove or Disconnect (Figure 10)

1. Instrument panel compartment. Refer to SECTION 10A4.
2. Steering column filler panel (13). Refer to SECTION 10A4.
3. Screw (12).
4. Cable (11) from heater module.
5. Cable (11) from steering column filler panel (13).

↔ Install or Connect (Figure 10)

1. Cable (11) to steering column filler panel (13).
2. Cable (11) to heater module.

NOTICE: Refer to "Notice" on page 1A-1.

3. Screw (12).

⌚ Tighten

- Screw (12) to 1.4 N.m (12 lbs. in.).

4. Steering column filler panel. Refer to SECTION 10A4.
5. Instrument panel compartment. Refer to SECTION 10A4.

BLOWER MOTOR RESISTOR

↔ Remove or Disconnect (Figure 11)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.

- Remove the compartment through the instrument panel opening. The resistor is installed on top the heater case.

3. Electrical connectors, as necessary.
4. Screws (15).
5. Resistor (14).

↔ Install or Connect (Figure 11)

1. Resistor (14).

NOTICE: Refer to "Notice" on page 1A-1.

1A-14 HEATER AND VENTILATION

2. Screws (15).



Tighten

- Screws (15) to 1.4 N.m (12 lbs. in.).
3. Electrical connectors, as necessary.
 4. Instrument panel compartment. Refer to SECTION 10A4.
 5. Negative battery cable.
 - Check circuit operation.

BLOWER MOTOR AND FAN



Remove or Disconnect (Figure 12)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.
3. Front screw from right door sill plate.
4. Right hinge pillar trim panel. Refer to SECTION 10A4.
5. Electrical connectors from ECM, as necessary.
6. ECM and mounting bracket.
7. Electrical connectors from blower motor (16), as necessary.
8. Courtesy lamp (if equipped).
9. Bolt from right lower dash support.
10. Blower motor cover.
11. Blower motor cooling tube (26).
12. Blower motor flange screws (22).
13. Blower motor (16).
 - Pull the blower motor forward carefully to avoid distorting the blower fan.

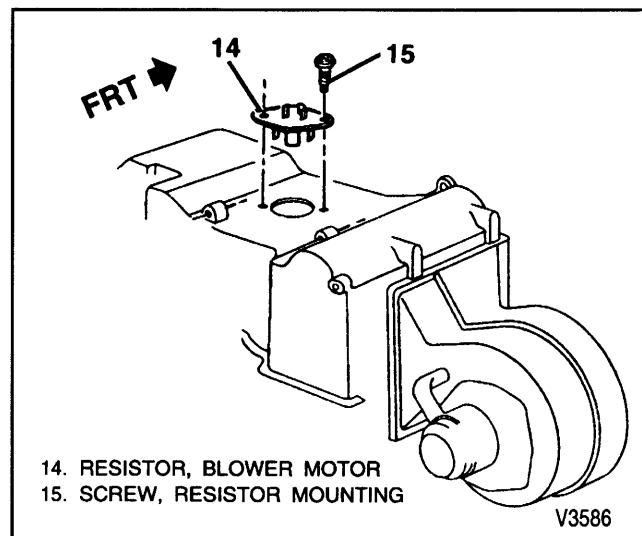


Figure 11—Blower Motor Resistor

- May be necessary to pry back right side of instrument panel.



Inspect

- Blower motor terminals for distortion. Clean corrosion from the terminals or replace the blower motor (16) as necessary.
- Flange of the blower motor (16) for damage or distortion that could cause an air leak. Repair as necessary.
- Blower fan for damage and distortion.

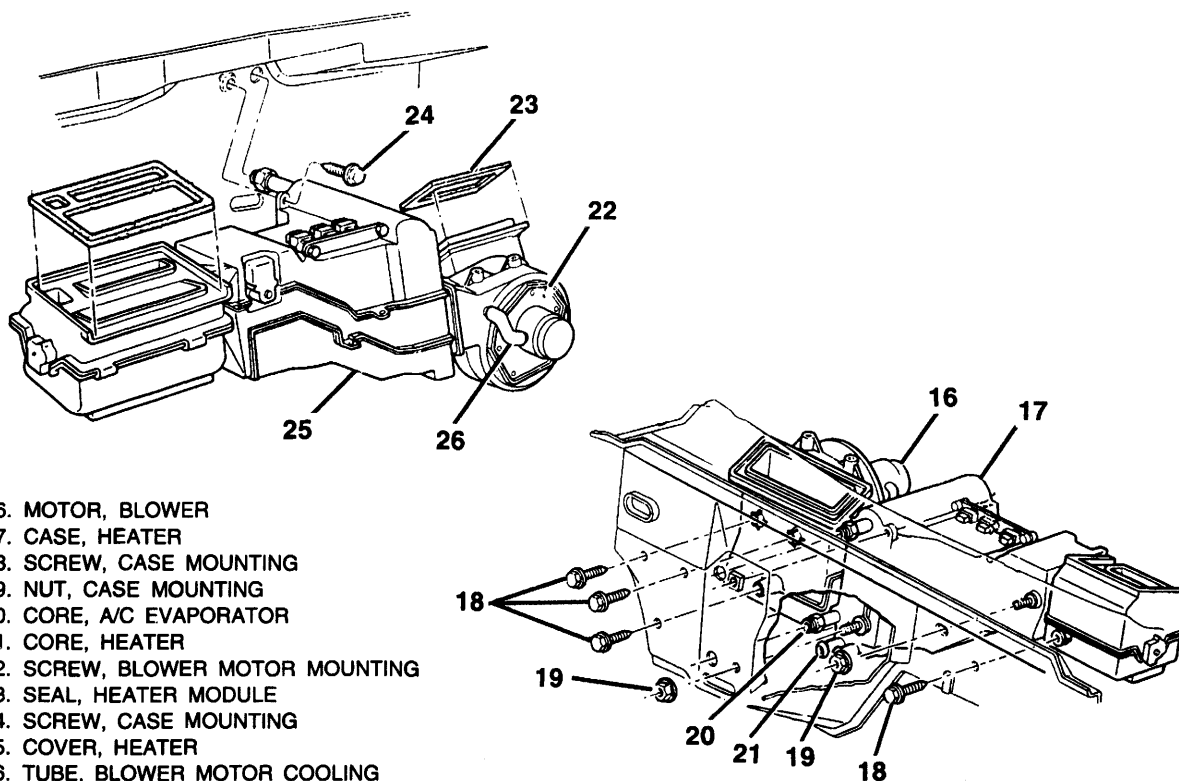


Figure 12—Heater Case Component View

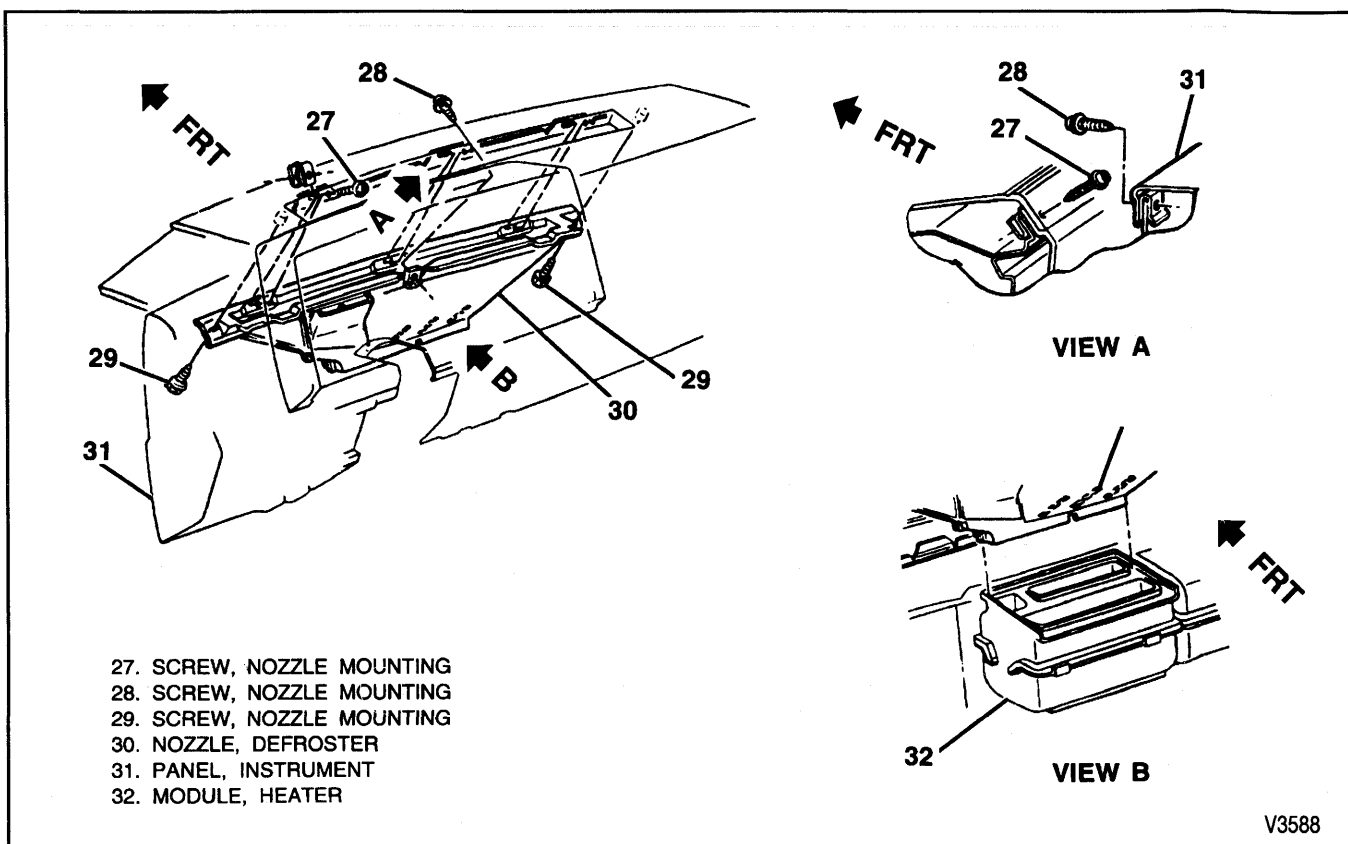


Figure 13—Defroster Nozzle



Install or Connect (Figure 12)

1. Blower motor (16).
 - Guide the blower motor and blower fan into position, being careful not to catch the blower fan on protruding parts.

NOTICE: For steps 2, 5, and 11, refer to "Notice" on page 1A-1.

2. Blower motor flange screws (22).
3. Blower motor cooling tube (26).
4. Blower motor cover.
5. Bolt to right lower dash support.
6. Courtesy lamp (if equipped).
7. Electrical connectors to blower motor (16), as necessary.
8. Mounting bracket and ECM.
9. Electrical connectors to ECM, as necessary.
10. Right hinge pillar trim panel. Refer to SECTION 10A4.
11. Front screw into front door sill plate.
12. Instrument panel compartment. Refer to SECTION 10A4.
13. Negative battery cable.
 - Check circuit operation.

DEFROSTER NOZZLE



Remove or Disconnect (Figure 13)

1. Tilt back instrument panel assembly (31). Refer to SECTION 10A4.

2. Screws (27).
3. Screws (28).
4. Screws (29).
5. Defroster nozzle (30).



Install or Connect (Figure 13)

1. Defroster nozzle (30).

NOTICE: For steps 2, 3, and 4, refer to "Notice" on page 1A-1.

2. Screws (29).



Tighten

- Screws (29) to 1.4 N.m (12 lbs. in.).
3. Screws (28).
 4. Screws (27).



Tighten

- Screws (27 and 28) to 1.9 N.m (17 lbs. in.).
5. Instrument panel. Refer to SECTION 10A4.

AIR DISTRIBUTOR DUCT



Remove or Disconnect (Figure 14)

1. Defroster nozzle (30). Refer to "Defroster Nozzle."
2. Five duct mounting screws (33).
 - Two from each side dash vent outlet.
 - One from center dash vent outlet.

1A-16 HEATER AND VENTILATION

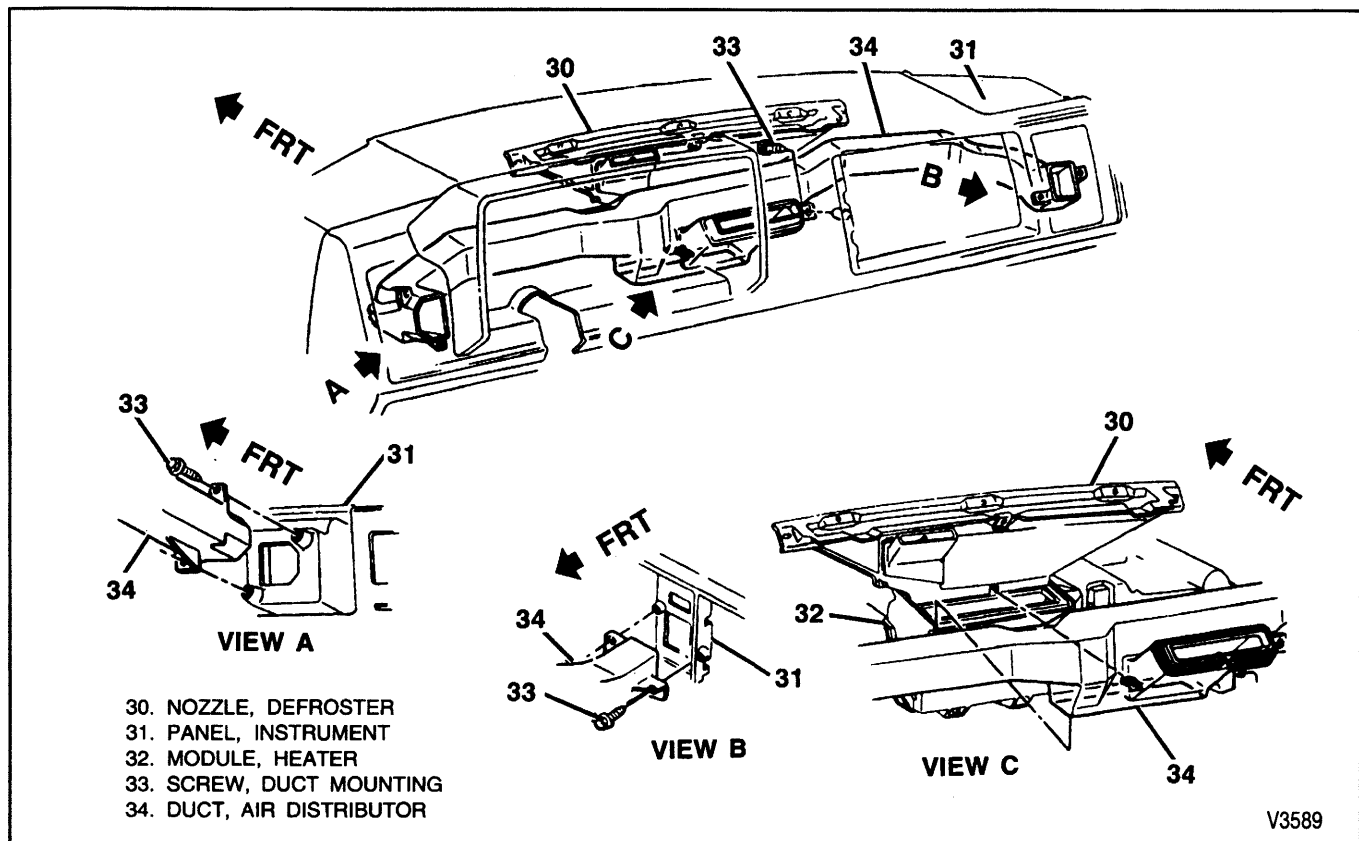


Figure 14—Air Distributor Duct

3. Duct (34) from instrument panel (31).

Install or Connect (Figure 14)

1. Duct (34) to instrument panel (31).

NOTICE: Refer to "Notice" on page 1A-1.

2. Duct mounting screws (33).

Tighten

- Screws (33) to 1.9 N.m (17 lbs. in.).

3. Defroster nozzle (30). Refer to "Defroster Nozzle."

HEATER HOSES

4.3L, 5.0L, 5.7L, AND 7.4L ENGINES

Heater Inlet Hose

Remove or Disconnect (Figures 15, 16, and 18)

Tool Required:

J 38723 Heater Line Quick Connect Separator
or Equivalent

1. Air cleaner.
2. Engine coolant. Refer to SECTION 6B1.
3. Inlet hose mounting screw (42).
4. Inlet hose clamp (36) at heater core.

- Loosen the clamp (36) enough to slide the clamp away from the fitting on the inlet hose (35).

5. Inlet hose (35) from heater core.
6. Push inlet hose (35) into connector (40) and insert J 38723 or equivalent into connector to release locking tabs (46) (figure 18).
7. Pull retainer (48) and hose (35) from heater inlet connector (40) (figure 18).

Inspect

- O-ring sealing surface on hose/pipe.

Adjust

- If replacing heater inlet connector, remove retainer from hose and discard, as new connector is equipped with retainer.
- If replacing hose, remove retainer from hose and reinsert in connector.
- If reusing hose and connector, retainer can remain in place on hose.

Install or Connect (Figures 15, 16, and 18)

1. Push hose into connector until retainer tabs lock.
 - Pull back on hose to check for proper engagement.
2. Inlet hose (35) to heater core.
3. Inlet hose clamp (36).

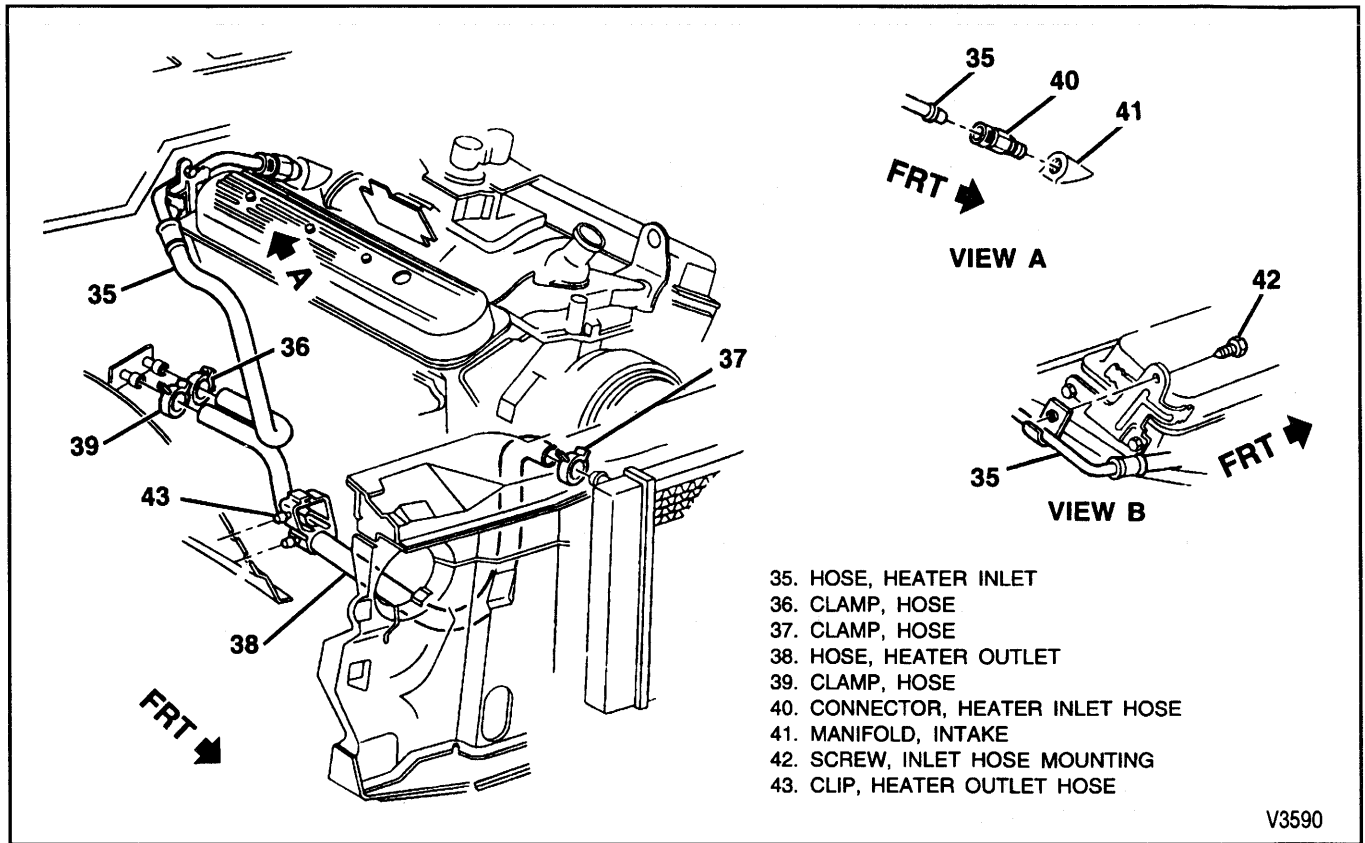


Figure 15—Heater Hose Routing (4.3L, 5.0L, and 5.7L Engines)

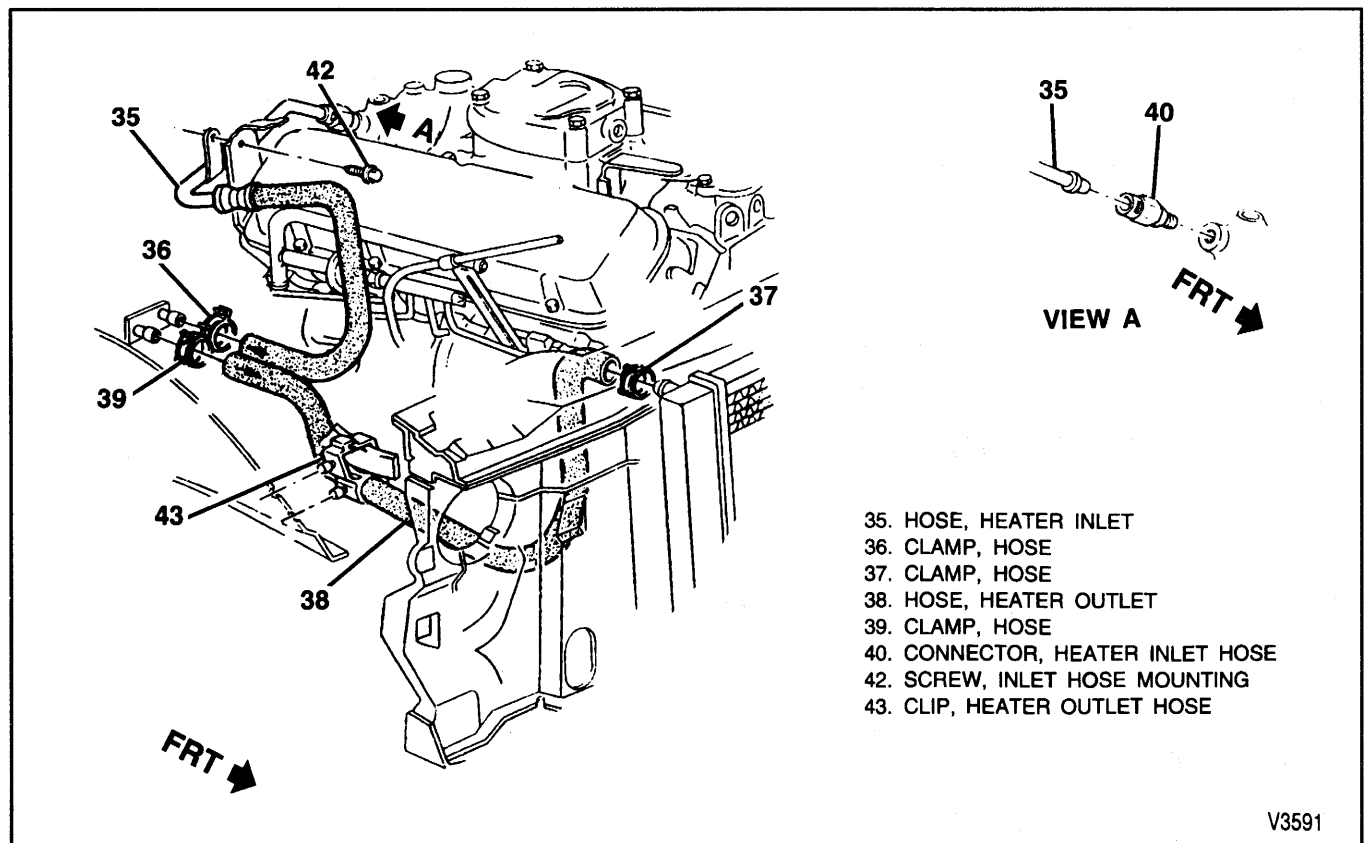


Figure 16—Heater Hose Routing (7.4L Engines)

1A-18 HEATER AND VENTILATION

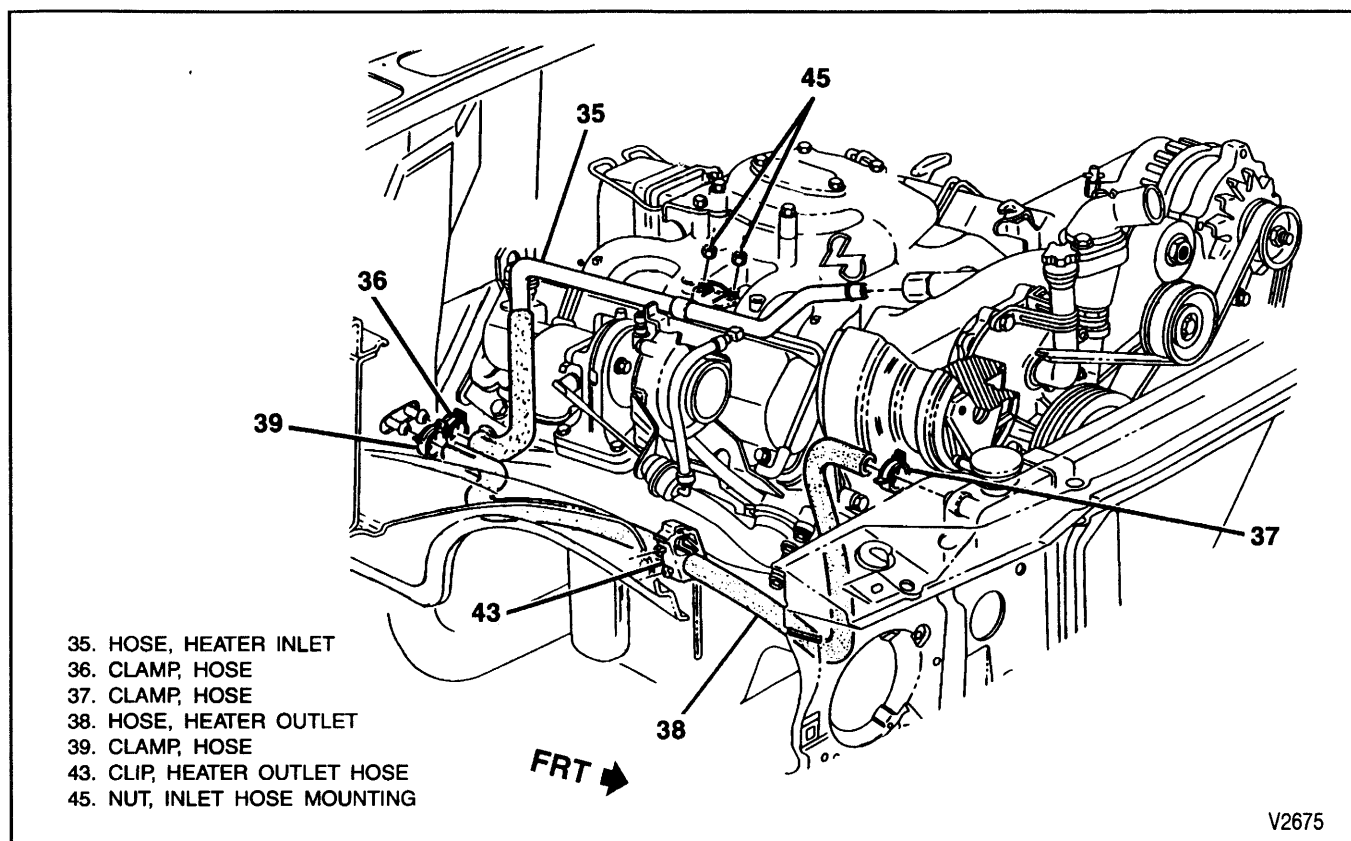


Figure 17—Heater Hose Routing (6.5L Diesel Engines)

NOTICE: Refer to "Notice" on page 1A-1.

6.5L DIESEL ENGINES

4. Inlet hose mounting screw (42).



Tighten

- Screw (42) to 1.4 N.m (12 lbs. in.).

5. Engine coolant. Refer to SECTION 6B1.
6. Air cleaner.

- Check the system for leaks.

Remove or Disconnect (Figure 17)

1. Engine coolant. Refer to SECTION 6B1.
2. Hose clamps (36, 37, 39, and 44).
3. Inlet hose (35).
4. Outlet hose clip (43).
5. Outlet hose (38).

Heater Outlet Hose

Remove or Disconnect (Figures 15 and 16)

1. Engine coolant. Refer to SECTION 6B1.
2. Hose clamps (37 and 39).
3. Outlet hose clip (43).
4. Outlet hose (38) from heater core.
5. Outlet hose (38) from radiator.

Install or Connect (Figures 15 and 16)

1. Outlet hose (38) to radiator.
2. Outlet hose (38) to heater core.
3. Outlet hose clip (43).
4. Hose clamps (37 and 39).
5. Engine coolant. Refer to SECTION 6B1.

- Check the system for leaks.

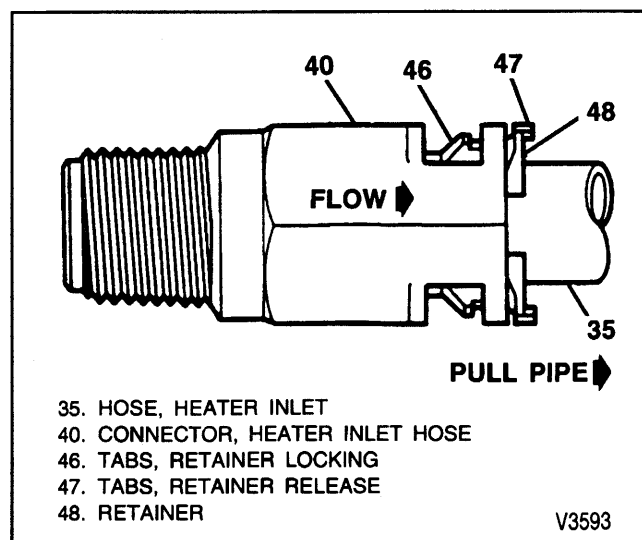


Figure 18—Quick Connect Heater Inlet Connector

Install or Connect (Figure 17)

1. Outlet hose (38).
2. Outlet hose clip (43).
3. Inlet hose (35).
4. Hose clamps (36, 37, 39, and 44).
5. Engine coolant.
 - Check the system for leaks.

HEATER CORE

Remove or Disconnect (Figure 12)

1. Engine coolant. Refer to SECTION 6B1.
2. Instrument panel compartment. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Center floor air distribution duct.
5. ECM and mounting tray.
6. Hinge pillar trim panels. Refer to SECTION 10A4.
7. Blower motor cover.
8. Blower motor (16). Refer to "Blower Motor and Fan."
9. Steering wheel. Refer to SECTION 3F.
10. Tilt back instrument panel. Refer to SECTION 10A4.
11. Coolant recovery reservoir. Refer to SECTION 6B1.
12. Heater hoses. Refer to "Heater Hoses."
13. Screw (24).
14. Screws (18).
15. Nuts (19).
16. Heater case (17).
 - It may be necessary to have an assistant when removing heater case.
17. Heater cover (25).
 - Remove seven screws that hold heater cover to the heater case.

18. Heater core from retainer.

Install or Connect (Figure 12)

NOTICE: For steps 4, 5, and 6, refer to "Notice" on page 1A-1.

1. Heater core into retainer.
2. Heater cover (25).
 - Make sure heater cover is properly sealed.
 - Install seven screws that hold heater cover to heater case.
3. Heater case (17).
 - May be necessary to have an assistant when installing heater case.
4. Nuts (19).
5. Screws (18).
6. Screw (24).

Tighten

- Screws (18) to 1.9 N.m (17 lbs. in.).
 - Nuts (19) to 2.8 N.m (25 lbs. in.).
 - Screw (24) to 11 N.m (97 lbs. in.).
7. Heater hoses. Refer to "Heater Hoses."
 8. Coolant recovery reservoir. Refer to SECTION 6B1.
 9. Instrument panel. Refer to SECTION 10A4.
 10. Steering wheel. Refer to SECTION 3F.
 11. Blower motor (16). Refer to "Blower Motor and Fan."
 12. Blower motor cover.
 13. Hinge pillar trim panels. Refer to SECTION 10A4.
 14. ECM and mounting tray.
 15. Center floor air distribution duct.
 16. Electrical connectors, as necessary.
 17. Instrument panel compartment. Refer to SECTION 10A4.
 18. Engine coolant. Refer to SECTION 6B1.
 - Check the system for leaks.

ON-VEHICLE SERVICE—AUXILIARY HEATER (SUBURBAN)

CONTROL SWITCH

Remove or Disconnect (Figure 19)

1. Instrument panel bezel (1). Refer to SECTION 8C.
2. Electrical connectors (3), as necessary.
3. Control switch (2) from instrument panel bezel (1).

Install or Connect (Figure 19)

1. Control switch (2) to instrument panel bezel (1).
2. Electrical connectors (3), as necessary.
3. Instrument panel bezel (1). Refer to SECTION 8C.
 - Check circuit operation.

FRONT OVERHEAD (AUX. HEATER AND A/C)

Remove or Disconnect (Figure 20)

1. Roof console (4). Refer to SECTION 10A4.
2. Electrical connectors (5), as necessary.

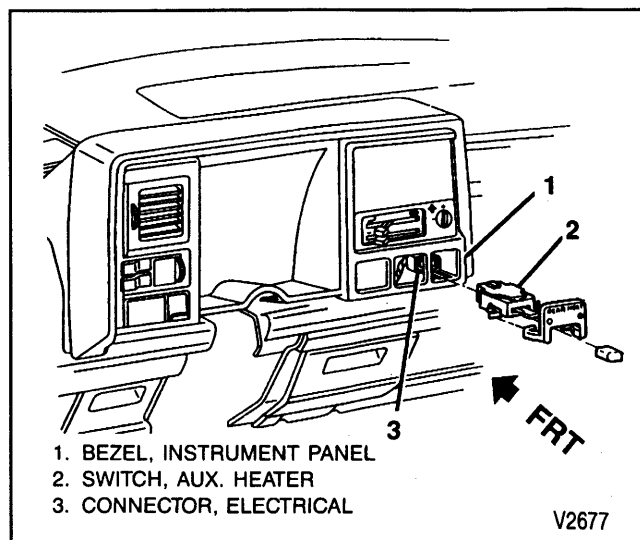


Figure 19—Auxiliary Heater Control Switch

1A-20 HEATER AND VENTILATION

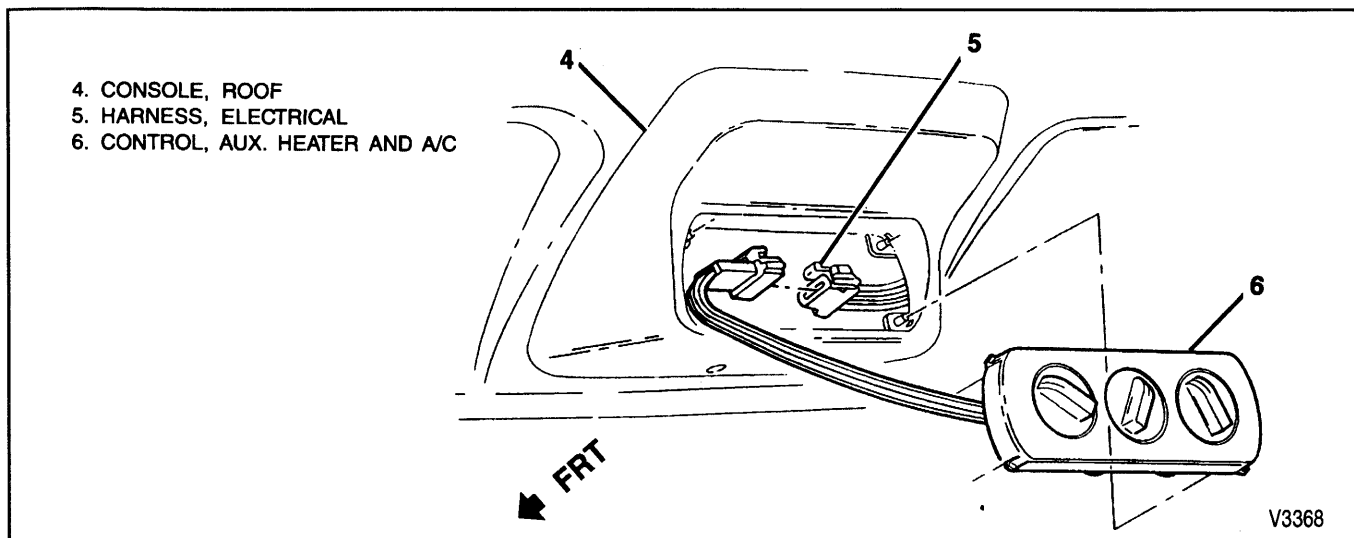


Figure 20—Front Overhead Auxiliary Control Switch

3. Control assembly (6) from roof console (4).

→→ Install or Connect (Figure 20)

1. Control assembly (6) to roof console (4).
2. Electrical connectors (5), as necessary.
3. Roof console (4). Refer to SECTION 10A4.
 - Check circuit operation.

CENTER OVERHEAD (AUX. HEATER AND A/C)

↔ Remove or Disconnect (Figure 21)

1. Bezel (8).
2. Control assembly (6) from roof panel (7).
3. Electrical connectors (5), as necessary.

→→ Install or Connect (Figure 21)

1. Electrical connectors (5), as necessary.
2. Control assembly (6) to roof panel (7).
3. Bezel (8).
 - Check circuit operation.

AUXILIARY HEATER PIPE

↔ Remove or Disconnect (Figures 22 and 23)

Tool Required:

J 38723 Heater Line Quick Connect Separator or Equivalent

1. Engine coolant. Refer to SECTION 6B1.
2. Hose clamps (13 and 24).
3. Heater outlet hose (12) from radiator.
4. Heater outlet hose (12) from auxiliary heater pipe (10).
5. Hose clamps (15 and 20).
6. Heater outlet hose (14) from heater core.
7. Heater outlet hose (14) from auxiliary heater pipe (10).
8. Hose clamps (17 and 19).
9. Heater inlet hose (18) from heater core.
10. Heater inlet hose (18) from auxiliary heater pipe (10).

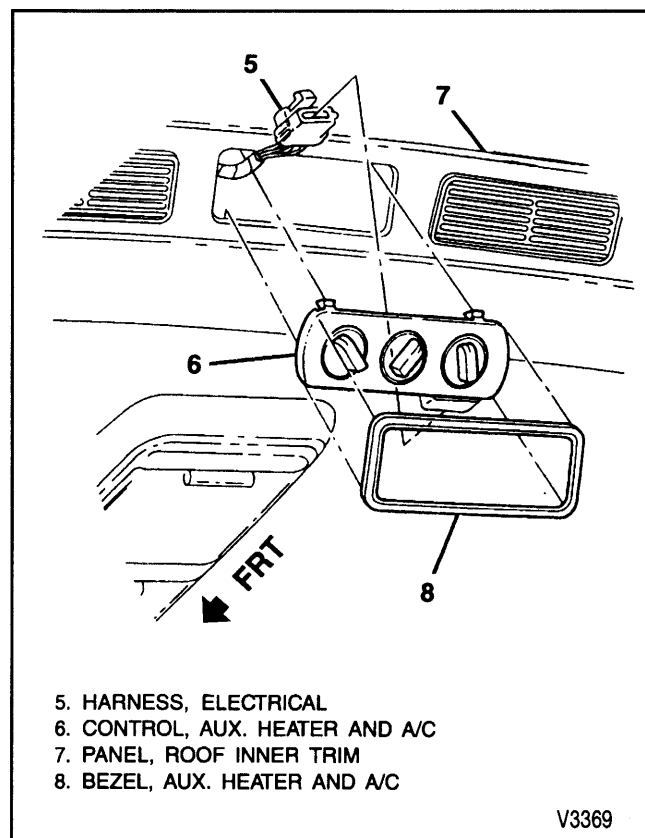


Figure 21—Center Overhead Auxiliary Control Switch

11. Hose clamp (21).
12. Heater inlet hose (16) from auxiliary heater pipe (10).
13. Push auxiliary inlet hose (22) or outlet hose (23) into auxiliary heater pipe (10) and insert J 38723 or equivalent into hose to release locking tabs.
14. Nut (9) (figure 22).
15. Auxiliary heater pipe (10).

Install or Connect (Figures 22 and 23)

1. Auxiliary heater pipe (12) (figure 22).

NOTICE: Refer to "Notice" on page 1A-1.

2. Nut (9).



Tighten

- Nut (9) to 15 N.m (11 lbs. ft.).
3. Push hose(s) (22 or 23) into auxiliary heater pipe (10) until retainer tabs lock.
 - Pull back on hose(s) to check for proper engagement.
 4. Heater inlet hose (16) to auxiliary heater pipe (10).
 5. Hose clamp (21).
 6. Heater inlet hose (18) to auxiliary heater pipe (10).
 7. Heater inlet hose (18) to heater core.
 8. Hose clamps (17 and 19).
 9. Heater outlet hose (14) to auxiliary pipe (10).
 10. Heater outlet hose (14) to heater core.
 11. Hose clamps (15 and 20).

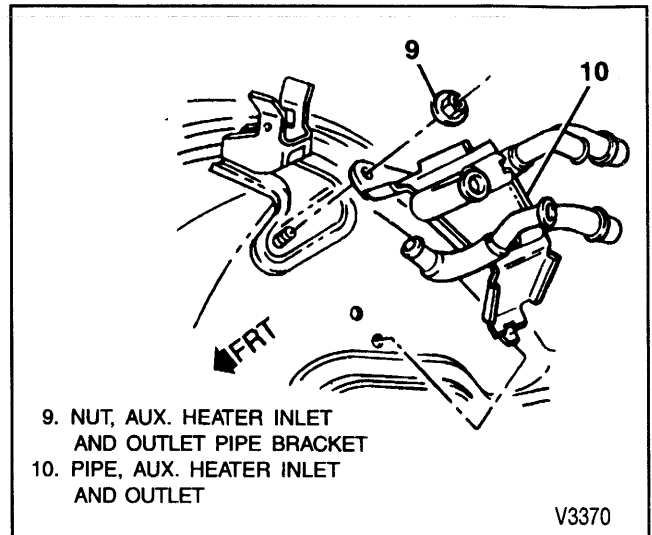


Figure 22—Auxiliary Heater Pipe

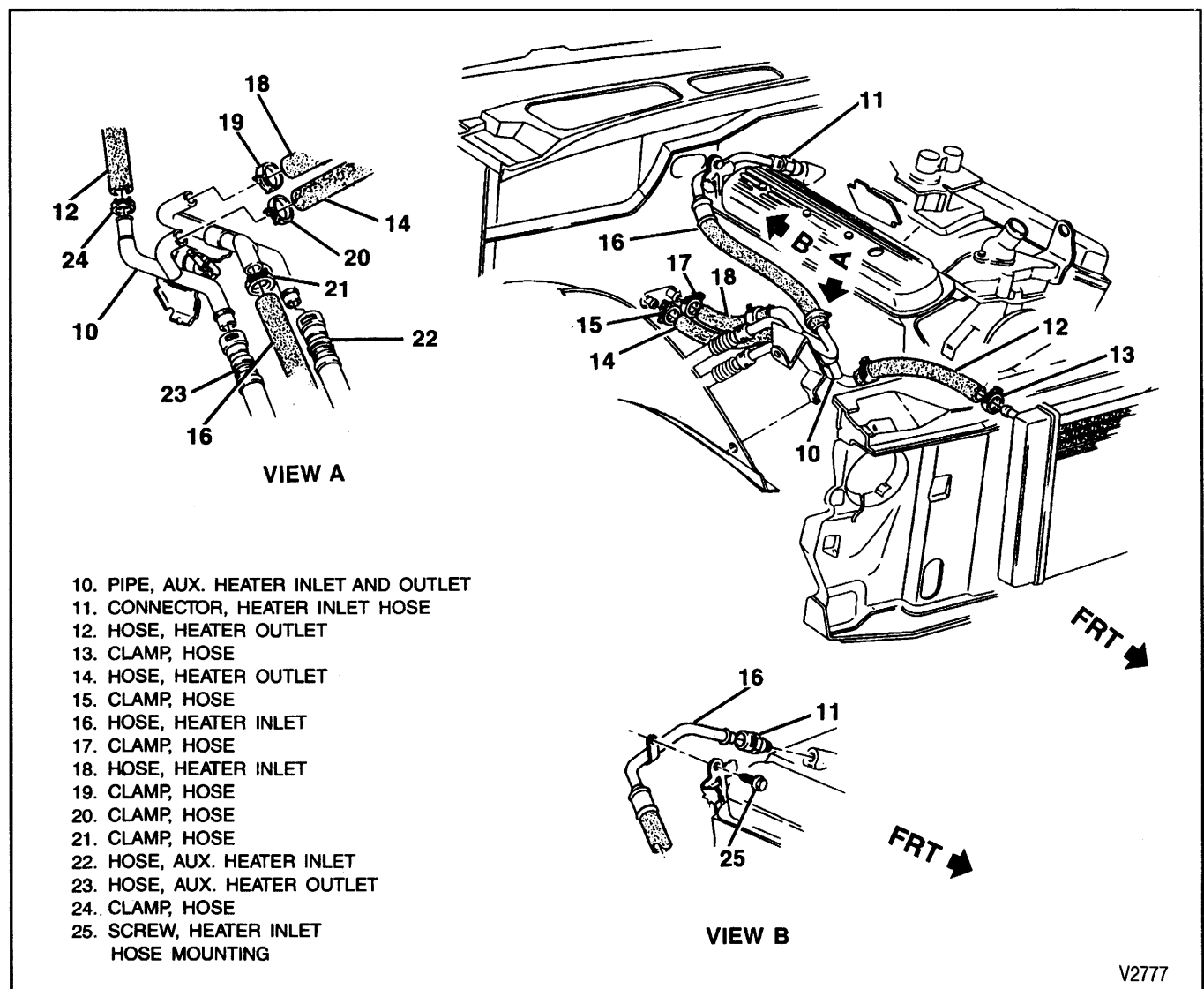


Figure 23—Auxiliary Heater Hose Routing

1A-22 HEATER AND VENTILATION

12. Heater outlet hose (12) to auxiliary heater pipe (10).
13. Heater outlet hose (12) to radiator.
14. Hose clamps (13 and 24).
15. Engine coolant. Refer to SECTION 6B1.
 - Check the system for leaks.

HEATER HOSES

FRONT AUXILIARY HOSE ASSEMBLY

↔ Remove or Disconnect (Figure 24)

Tool Required:

J 38723 Heater Line Quick Connect Separator or Equivalent

- Raise the vehicle and support with suitable safety stands.
1. Engine coolant. Refer to SECTION 6B1.
 2. Right front wheelhouse. Refer to SECTION 2B.
 3. Bolts (27 and 28).
 4. Front hose assembly (26) from auxiliary heater pipe (10).
 - Push front hose assembly (26) into auxiliary heater pipe (10) and insert J 38723 or equivalent into hose to release locking tabs.
 5. Front hose assembly (26) from rear hose assembly (30).
 - Push auxiliary hose assembly (26) into rear hose assembly (30) and insert J 38723 or equivalent into hose to release locking tabs.

↔ Install or Connect (Figure 24)

1. Front hose assembly (26) to auxiliary heater pipe (10).
 - Push hose assembly into auxiliary heater pipe until retainer tabs lock.
2. Front hose assembly (26) to rear hose assembly (30).
 - Push hose assembly into rear hose assembly until retainer tabs lock.

NOTICE: Refer to "Notice" on page 1A-1.

3. Bolts (27 and 28).

⌚ Tighten

- Bolts (27 and 28) to 17 N.m (13 lbs. ft.).
4. Right front wheelhouse. Refer to SECTION 2B.
 5. Engine coolant. Refer to SECTION 6B1.
 - Lower the vehicle.
 - Check the system for leaks.

REAR AUXILIARY HOSE ASSEMBLY

↔ Remove or Disconnect (Figures 24 and 25)

Tool Required:

J 38723 Heater Line Quick Connect Separator or Equivalent

- Raise the vehicle and support with suitable safety stands.

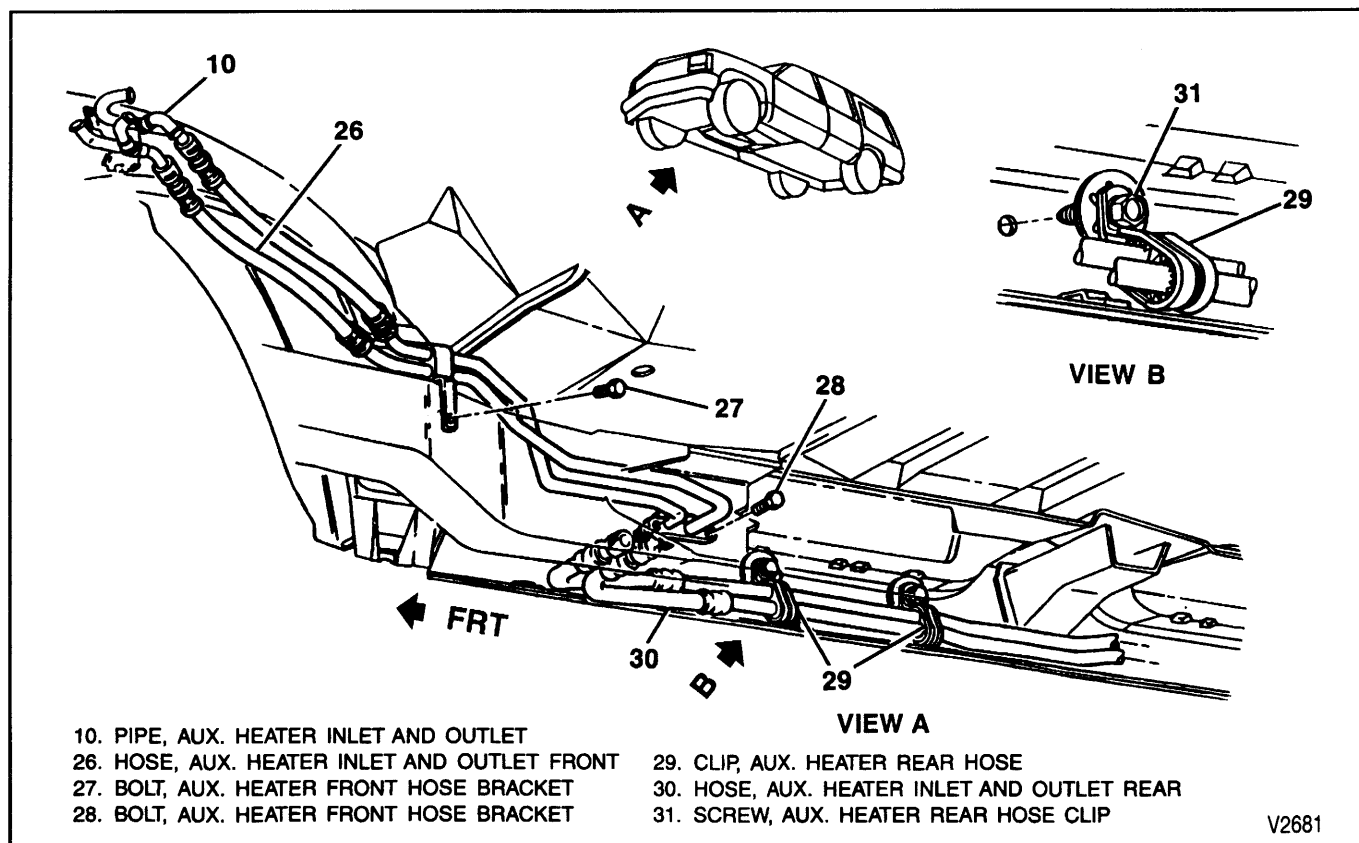


Figure 24—Auxiliary Heater Hose Assembly Routing (Front)

1. Engine coolant. Refer to SECTION 6B1.
2. Bolts (31).
3. Rear hose assembly (30) from front hose assembly (26) (figure 24).
 - Push rear hose assembly (30) into front hose assembly (26) and insert J 38723 or equivalent into hose to release locking tabs.
4. Rear hose assembly (30) from auxiliary heater core (32).
 - Push rear hose assembly (30) into auxiliary heater core (32) and insert J 38723 or equivalent into hose to release locking tabs.

Install or Connect (Figures 24 and 25)

1. Rear hose assembly (30) to front hose assembly (26) (figure 24).
 - Push rear hose assembly into front hose assembly until retainer tabs lock.
2. Rear hose assembly (30) to auxiliary heater core (32).
 - Push rear hose assembly into auxiliary heater core until retainer tabs lock.

NOTICE: Refer to "Notice" on page 1A-1.

3. Bolts (31).



Tighten

- Bolts (31) to 17 N·m (13 lbs. ft.).
4. Engine coolant. Refer to SECTION 6B1.
 - Lower the vehicle.
 - Check the system for leaks.

HEATER CORE

Remove or Disconnect (Figure 26)

1. Engine coolant. Refer to SECTION 6B1.
2. Rear quarter interior trim, as necessary. Refer to SECTION 10A4.
3. Right rear quarter trim panel. Refer to SECTION 10A4.
4. Right rear wheelhouse. Refer to SECTION 2B.
5. Auxiliary heater hoses from heater core. Refer to "Heater Hoses."

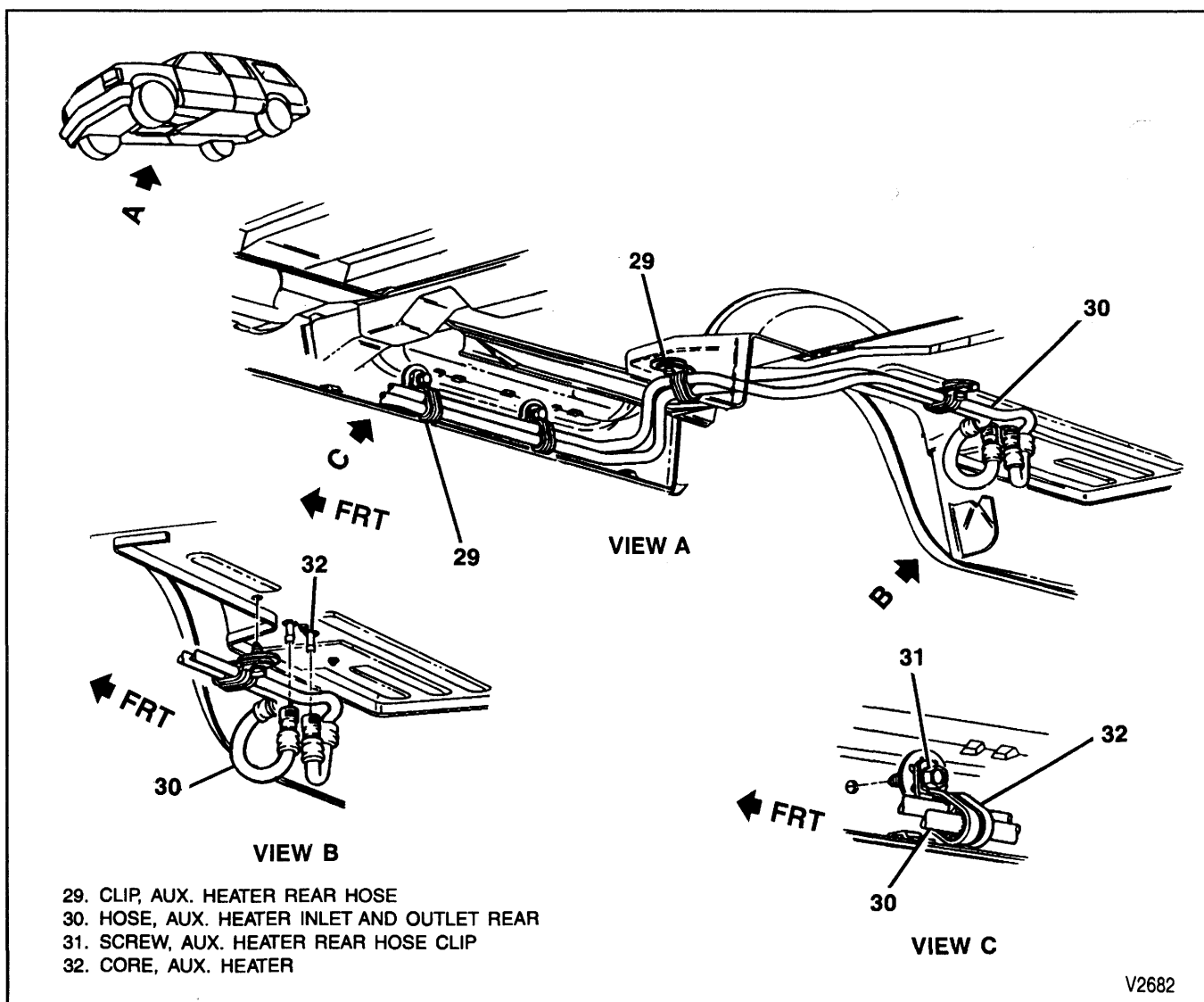


Figure 25—Auxiliary Heater Hose Assembly Routing (Rear)

1A-24 HEATER AND VENTILATION

6. Electrical connectors, as necessary.
7. Drain valve.
8. Bolts (33).
9. Nuts (36).
10. Heater module (37).
11. Blower motor, if necessary.
12. Heater case cover.
13. Heater core.

Install or Connect (Figure 26)

1. Heater core.
2. Heater case cover.
3. Blower motor, if necessary.
4. Heater module (37).

NOTICE: For steps 5 and 6, refer to "Notice" on page 1A-1.

5. Nuts (36).
6. Bolts (33).



Tighten

- Bolts (33) to 1.5 N.m (13 lbs. in.).
 - Nuts (36) to 10 N.m (89 lbs. in.).
7. Drain valve.
 8. Electrical connectors, as necessary.
 9. Auxiliary heater hoses to heater core (29). Refer to "Heater Hoses."
 10. Right rear wheelhouse. Refer to SECTION 2B.
 11. Right rear quarter trim panel. Refer to SECTION 10A4.

12. Rear quarter interior trim, as necessary. Refer to SECTION 10A4.
13. Engine coolant. Refer to SECTION 6B1.
 - Check the system for leaks.

BLOWER MOTOR AND FAN



Remove or Disconnect (Figure 27)

1. Negative battery cable. Refer to SECTION 0A.
2. Right rear quarter trim panel cover. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Screws (39).
 - Position blower motor in order to remove blower motor fan.
5. Blower motor fan retaining nut.
6. Blower motor fan.
7. Blower motor (38).



Install or Connect (Figure 27)

1. Blower motor (38).
2. Blower motor fan.
3. Blower motor fan retaining nut.

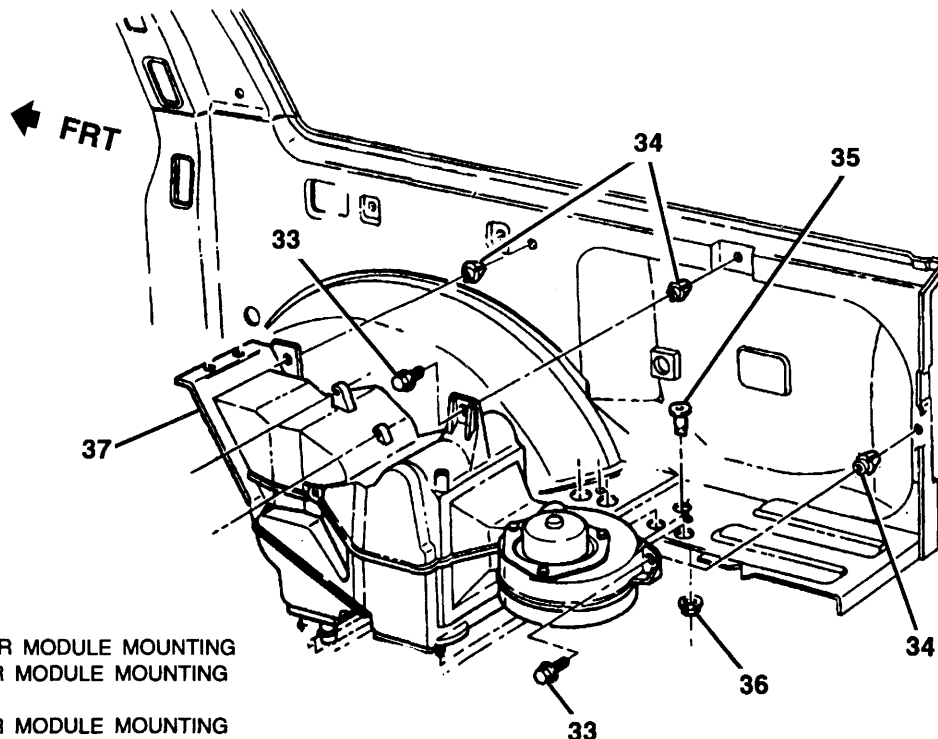
NOTICE: Refer to "Notice" on page 1A-1.

4. Screws (39).



Tighten

- Screws (39) to 1.4 N.m (12 lbs. in.).



33. BOLT, AUX. HEATER MODULE MOUNTING
34. NUT, AUX. HEATER MODULE MOUNTING
35. VALVE, DRAIN
36. NUT, AUX. HEATER MODULE MOUNTING
37. MODULE, AUX. HEATER

V3371

Figure 26—Auxiliary Heater Module

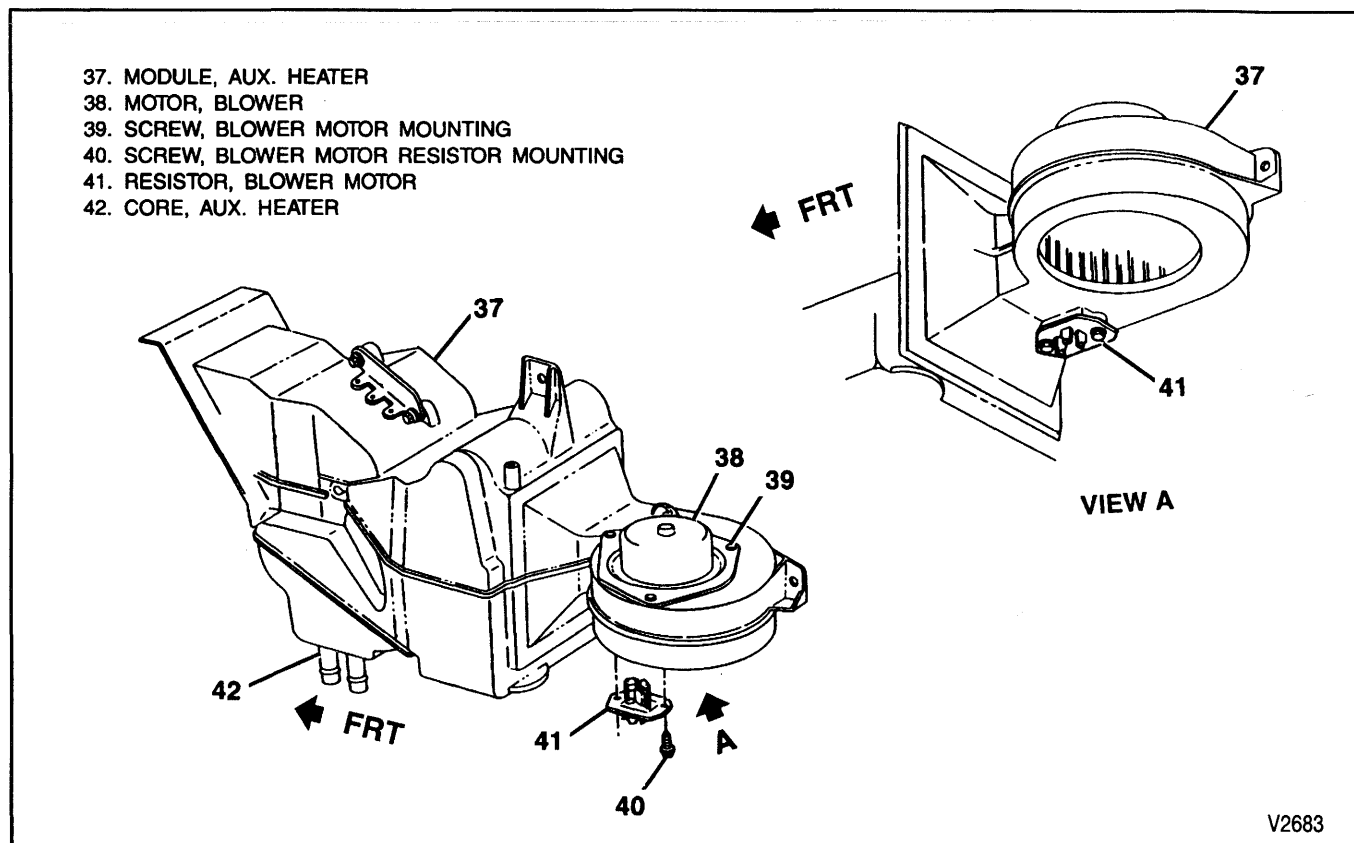


Figure 27—Auxiliary Blower Motor/Resistor

5. Electrical connectors, as necessary.
6. Right rear quarter trim panel cover. Refer to SECTION 10A4.
7. Negative battery cable.

- Check circuit operation.

BLOWER MOTOR RESISTOR

Remove or Disconnect (Figure 27)

1. Negative battery cable. Refer to SECTION 0A.
2. Right rear quarter trim panel cover. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Screws (40).
5. Blower motor resistor (41).

Install or Connect (Figure 27)

1. Blower motor resistor (41).

NOTICE: Refer to "Notice" on page 1A-1.

2. Screws (40).

Tighten

- Screws (40) to 1.4 N·m (12 lbs. in.).
3. Electrical connectors, as necessary.
 4. Right rear quarter trim panel cover. Refer to SECTION 10A4.
 5. Negative battery cable.
- Check circuit operation.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Lbs. Ft.	Lbs. In.
Air Inlet Valve-to-Instrument Panel Screw	1.9	—	17
Auxiliary Heater Module Mounting Bolts	1.5	—	13
Auxiliary Heater Module Mounting Nuts	10	—	89
Auxiliary Heater Pipe Mounting Nut	15	11	—
Blower Motor Mounting Screw	1.4	—	12
Blower Motor Resistor Mounting Screw	1.4	—	12
Control Assembly Mounting Screw	1.6	—	14
Cowl Panel-to-Heater Case Mounting Screw	1.9	—	17
Defroster Nozzle Mounting Screw	1.9	—	17
Defroster Nozzle-to-Heater Case Mounting Screw	1.4	—	12
Distributor Duct Mounting Screw	1.9	—	17
Front Auxiliary Hose Assembly-to-Frame Mounting Screw	17	13	—
Heater Case-to-Cowl Panel Mounting Nut	2.8	—	25
Heater Case-to-Cowl Panel Mounting Screw	11	—	97
Rear Auxiliary Hose Clip-to-Frame Mounting Bolts	17	13	—
Right Vent Cable-to-Heater Case	1.4	—	12

T2963

SPECIAL TOOLS

1.



J 38723

1. HEATER LINE QUICK CONNECT SEPARATOR

V3437

SECTION 1B**HEATER, VENTILATION, AND AIR
CONDITIONING**

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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1B-2 HEATER, VENTILATION, AND AIR CONDITIONING

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GENERAL DESCRIPTION

CCOT A/C SYSTEM

The cycling clutch orifice tube (CCOT) refrigerant system is designed to cycle a compressor on and off to maintain desired cooling and to prevent evaporator freeze-up. Passenger compartment comfort is maintained by the temperature selector on the controller (figure 1).

Control of the refrigeration cycle (on and off operation of the compressor) is done with a switch which senses low side pressure as an indicator of evaporator pressure. The cycling pressure switch is the freeze protection device in the system and senses refrigerant pressure on the suction side of the system. This switch is located on a standard service low-side fitting. During air temperatures of 16-26°C (60-80°F), the equalized pressures within the charged air conditioning system will close the contacts of the pressure switch.

When an air conditioning mode is selected, electrical energy is supplied to the compressor clutch coil. As the compressor reduces the evaporator pressure to approximately 175 kPa (25 psi), the pressure switch will open, de-energizing the compressor clutch. As the system equalizes and the pressure reaches approximately 315 kPa (46 psi), the pressure switch contacts close, re-energizing the clutch coil. This cycling continues and maintains evaporator discharge air temperature at approximately 1°C (33°F).

Because of this cycling, some slight increases and decreases of engine speed/power may be noticed under certain conditions. This is normal as the system is designed to cycle to maintain desired cooling, thus preventing evaporator freeze-up.

Additional compressor protection results from the operating characteristics of the low-side cycling pressure system. If a massive discharge occurs in the low side of the system, or the orifice tube becomes plugged, low-side pressures could be insufficient to close the contacts of the pressure switch. In the event of a low charge, insufficient cooling accompanied by rapid compressor clutch cycling will be noticed at high air temperatures.

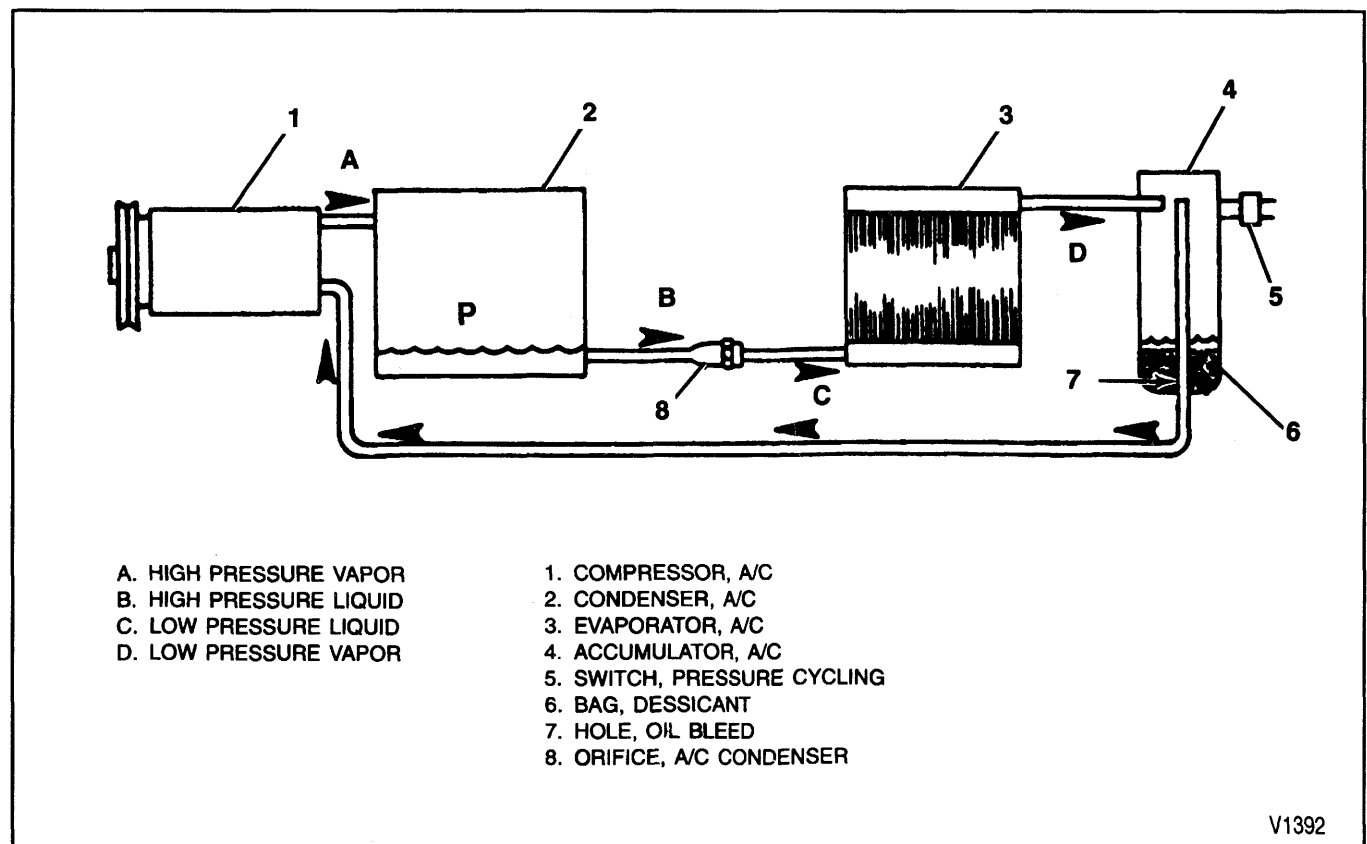
When the engine is turned "OFF" with the air conditioning system operating, the refrigerant in the system will flow from the high-pressure side of the expansion tube (orifice) to the low-pressure side until the pressure is equalized. This may be detected as a hissing sound for 30 to 60 seconds and is a normal condition.

The air conditioning systems that are available for this vehicle are described below:

- C60—Front Manual Controls, HVAC System
- C69—Rear Roof Mounted, HVAC System

UNIT REPAIR INFORMATION

For bench repair of the Harrison HR110-MD air conditioning compressor, refer to the Light Duty Truck Unit Repair Manual.



V1392

Figure 1—System Components

1B-4 HEATER, VENTILATION, AND AIR CONDITIONING

CONTROLS

All C/K models are equipped with an electronically controlled air conditioning system. The control head functions are controlled by four rocker and three push-button switches (figure 2).

The four rocker switches are for "Temperature Select," "Fan Speed," "Upper/Vent-Lower" and "Defrost/Heater-Lower."

The three pushbutton switches are "A/C," "MAX" (Recirculation), and "OFF."

Automatic recirculation will occur when compressor head pressures exceed 2275 kPa (330 psi) and disable after head pressures reach 1724 kPa (250 psi). The system requires a 20 second delay for activation and a 20 minute on-time. When activated, it cannot be manually disabled by the "MAX" button.

AIR DISTRIBUTION SYSTEM

Control of airflow through the HVAC module is regulated by electronic-actuated doors. At various positions of the rocker switches on the control assembly, mode doors mix and direct cooled, heated, and outside air through the air ducts.

DUCTS AND OUTLETS

A system of ducts and outlets directs air to the passenger compartment. In cases of poor air output, defroster, heater, air conditioning, and vent ducts should be checked for obstructions such as leaves, dirt, or objects which may have fallen into the ducts from the passenger compartment.

REFRIGERATION SYSTEM

ACCUMULATOR

The sealed accumulator assembly is connected to the evaporator outlet pipe. It functions as a liquid/vapor separator that receives refrigerant vapor, some liquid refrigerant and refrigerant oil from the evaporator. It only allows refrigerant vapor and oil to continue on to the compressor.

At the bottom of the accumulator is the desiccant that acts as a drying agent for moisture that may have entered the system. An oil bleed hole is also located near the bottom of the accumulator outlet pipe to provide an oil return path to the compressor.

A low-side pressure service fitting is located on the accumulator. A similar service fitting is provided for mounting the cycling pressure switch. It is not neces-

sary to discharge the system to replace the switch. The accumulator is serviced only as a replacement assembly.

COMPRESSOR

The Harrison HR110-MD compressor is driven by a belt from the engine crankshaft through the compressor clutch pulley. The compressor pulley rotates freely, without turning the compressor shaft, until an electromagnetic clutch coil is energized. When voltage is applied to energize the clutch coil, a clutch plate and hub assembly is drawn rearward toward the pulley. The magnetic force locks the clutch plate and pulley together as one unit to drive the compressor shaft.

All replacement compressors from service parts will have 240 ml (8 fl. oz.) of oil in the crankcase, the oil must be drained and retained. Then replace the oil in the same amount as previously recorded from the old compressor.

CONDENSER

The condenser assembly in front of the radiator is made up of coils, which carry the refrigerant, and cooling fins, which provide rapid transfer of heat. The air passing through the condenser cools the high-pressure refrigerant vapor causing it to condense into a liquid.

EXPANSION TUBE (ORIFICE)

The plastic expansion tube, with its mesh screen and orifice is located in the condenser outlet pipe. It provides a restriction to the high-pressure liquid refrigerant in the liquid line, metering the flow of refrigerant to the evaporator as a low-pressure liquid. The expansion tube and orifice are protected from contamination by filter screens on both inlet and outlet sides. The tube is serviced only as a replacement assembly.

When the engine is turned "OFF" with the air conditioning operating, the refrigerant in the system will flow from the high-pressure side of the expansion tube (orifice) to the low-pressure side until the pressure is equalized. This may be detected as a faint sound of liquid flowing (hissing) for 30 to 60 seconds and is a normal condition.

When system diagnostics indicate a restricted expansion tube, it may not be necessary to replace it. Metal chips, flakes, or slivers found on the screen may be removed with compressed air and the expansion tube may be reused if:

- The plastic frame is not broken.
- The expansion tube is not damaged or plugged.
- The screen material is not torn.
- The screen is not plugged with fine gritty material.

EVAPORATOR

The evaporator is a device which cools and dehumidifies the air before it enters the vehicle. High pressure liquid refrigerant flows through the orifice tube into the low-pressure area of the evaporator. The heat in the air passing through the evaporator core is lost to the cooler surface of the core, thereby cooling the air. As the process of heat loss from the air to the evaporator core surface is taking place, any moisture (humidity) in the air condenses on the outside surface of the evaporator core and is drained off as water.

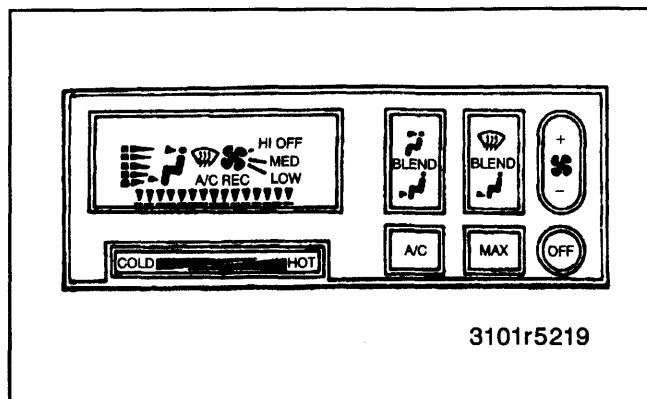


Figure 2—Control Head Description

HEATER CORE

In any air conditioning mode, the heater core can be used to heat the cool dehumidified air to achieve the desired temperature. The position of the control assembly temperature selector will determine how much heat will be added to the incoming air.

HIGH PRESSURE RELIEF VALVE

The compressor is equipped with a pressure relief valve which is placed in the system as a safety factor. Under certain conditions, the refrigerant on the discharge side may exceed the designed operating pressure. To prevent system damage, the valve is designed to open automatically at approximately 3036 kPa (440 psi). Any condition that causes the valve to open should be corrected, and the refrigerant should be replaced as necessary.

REFRIGERANT-134a

CAUTION: Avoid breathing A/C Refrigerant-134a and lubricant vapor and mist. Exposure may irritate eyes, nose, and throat. To remove R-134a from the A/C system, use service equipment certified to meet the requirements of SAE J2210 (R-134a recycling equipment). If accidental system discharge occurs, ventilate work area before resuming service. Additional health and safety information may be obtained from refrigerant and lubricant manufacturers.

Like the coolant in the engine cooling system, the refrigerant is the substance in the air conditioning system that absorbs, carries, and then releases heat. Although various substances are used as refrigerants in other types of refrigeration systems, past automotive air conditioning systems used a type called Refrigerant-12 (R-12).

This vehicle uses a new type of refrigerant called Refrigerant-134a (R-134a). It is a non-toxic, non-flammable, clear, colorless liquified gas.

While the R-134a A/C system is very similar to an R-12 A/C system, the differences in the refrigerant, lubricants, and service equipment are important.

NOTICE: R-134a refrigerant is not compatible with R-12 refrigerant in an air conditioning system. R-12 in a R-134a system will cause compressor failure, refrigerant oil sludge, or poor air conditioning system performance.

Refrigerant-134a carries a charge of a special lubricant, polyalkaline glycol (PAG) refrigerant oil. GM (PAG) refrigerant oil will have a slight blue tint. The oil is hygroscopic (absorbs water from the atmosphere) and should be stored in closed containers.

HEATER SYSTEM

The air conditioning system operates on the reheat principle in which all the air passing through the system is chilled almost to a freezing temperature and then reheated to a more comfortable temperature before it is discharged into the passenger compartment.

The dehumidified air is reheated as it passes through the heater core in the air conditioning module. The heater is warmed by engine coolant passing through the tubes of the heater core. This heat is transferred to the heater core fins and given off to the airflowing past the fins. The position of the air temperature air valve in the air conditioning module determines how much of the total airflow is allowed to pass through the heater. In turn, this determines the warmth of the total airflow discharged into the passenger compartment.

RELAYS AND SWITCHES

BLOWER MOTOR RELAY

The blower motor relay is used to provide battery voltage to the blower motor assembly only during high blower motor assembly speed. The blower motor resistor is used to provide power to the blower motor assembly in all other speed settings.

COMPRESSOR PRESSURE SWITCH

This system is equipped with a compressor pressure switch. This switch is normally open, activates at 2069-2482 kPa (300-360 psi) and releases at 1724 kPa (250 psi).

It's function is to drive the air distribution door in the module to recirculation position to reduce the system load and decrease system high-side pressure. It also activates the auxiliary fan on 7.4L (L19) applications.

HIGH PRESSURE CUTOFF SWITCH

The system is also equipped with a high pressure cutoff switch. This switch is normally closed, and opens at 2827-3103 kPa (410-450 psi) to interrupt the voltage to the compressor clutch coil. This will stop the compressor from cycling and prevent the pressure relief valve from discharging refrigerant and oil.

PRESSURE CYCLING SWITCH

The refrigeration cycle (on and off operation of the compressor) is controlled by a switch which senses the low-side pressure as an indicator of evaporator temperature. The pressure cycling switch is the freeze protection device in the system and senses refrigerant pressure on the suction side of the system. This switch is mounted on a standard service low-side fitting. This switch also provides compressor cutoff during cold weather.

Additional compressor protection results from the operating characteristics of the low-side pressure cycling system. If a massive discharge occurs in the low side of the system, or the orifice tube becomes plugged, low-side pressures could be insufficient to close the contacts of the pressure switch. In the event of a low charge, insufficient cooling accompanied by rapid compressor clutch cycling will be noticed at high outside (ambient) air temperatures.

If replacement of the pressure cycling switch is necessary, it is important to note that this may be done without removing the refrigerant charge. A service fitting is located in the pressure switch fitting. During replacement of the pressure switch, a new O-ring seal must be installed and the switch assembled to the specified torque of 4.5 N·m (40 lbs. in.).

REFRIGERANT SYSTEM DIAGNOSIS

REFRIGERANT SYSTEM CHECKS

FUNCTIONAL TEST

To aid in determining whether or not the air conditioning, electrical, air, and refrigeration systems are operating properly, refer to "Performance Test." For additional electrical diagrams and diagnostic information, refer to the Driveability, Emissions, and Electrical Diagnosis Manual for these models.

1. Operation of the air conditioning blower at all speeds, in any position except "OFF" and engagement of the compressor clutch would indicate that the electrical circuits are functioning properly.
2. The same "Hand-Felt" temperature of the evaporator inlet pipe and the accumulator surface of an operating system would indicate a properly charged system.
3. Operation of the air conditioning control head to distribute air from the designed outlets would indicate proper functioning.

PERFORMANCE TEST

Tool Required:

J 21213-A Four Jack-Dual Range Temperature Tester or Equivalent

1. Park vehicle inside or in a shaded area.
2. Open doors or windows to ventilate interior.
3. Vent engine exhaust if necessary.

4. Open hood and install high and low side pressure gages. Route lines over rear hood seal, and tape gages to windshield for viewing.
5. Close hood.
6. Record ambient temperature at vehicle.
7. Record relative humidity. Use psychrometer or consult local weather bureau.



Important

- Be sure to record relative humidity and ambient temperature conditions at time of test.
8. Close doors or windows.
 9. Press "A/C" button, adjust blower speed to "HI," and temperature to full "COLD."
 10. Open air conditioning outlets.
 11. Install J 21213-A or equivalent into right center air conditioning outlet.
 12. Place transmission in "PARK" or "NEUTRAL."
 13. Start engine, stabilize engine speed at 2000 RPM, and start the timer.
 14. Run air conditioning system until outlet air reaches the lowest temperature (about 3 minutes).
 15. Record outlet air temperature and high side and low side pressures.
 16. Turn the engine off and compare the readings. Normally operating air conditioning systems should not exceed the levels shown (figures 3 and 4).

PSIG	TEMP (°F) R-134A	PSIG	TEMP (°F) R-134A	PSIG	TEMP (°F) R-134A	PSIG	TEMP (°F) R-134A
0	-14.7	25	29.3	70	69.6	200	130.1
1	-12.1	26	30.5	75	72.9	210	133.5
2	-9.6	27	31.7	80	76.1	220	136.7
3	-7.2	28	32.9	85	79.2	230	139.8
4	-4.9	29	34.0	90	82.2	240	142.9
5	-2.7	30	35.1	95	85.0	250	145.9
6	-0.6	32	37.4	100	87.8	260	148.8
7	1.4	34	39.5	105	90.5	270	151.6
8	3.4	36	41.6	110	93.1	280	154.3
9	5.3	38	43.6	115	95.6	290	157.0
10	7.1	40	45.6	120	98.0	300	159.6
11	8.9	42	47.4	125	100.4	310	162.2
12	10.6	44	49.2	130	102.7	320	164.7
13	12.3	46	51.0	135	104.9	330	167.2
14	13.9	48	52.8	140	107.1	340	169.6
15	15.4	50	54.5	145	109.3	350	171.9
16	17.0	52	56.4	150	111.4	360	174.2
17	18.5	54	57.8	155	113.3	370	176.5
18	19.9	56	59.3	160	115.4	380	178.7
19	21.4	58	60.8	165	117.4	390	180.7
20	22.8	60	62.4	170	119.3	400	183.1
21	24.1	62	63.9	175	121.2		
22	25.5	64	65.4	180	123.0		
23	26.8	66	66.8	185	124.8		
24	28.0	68	68.2	190	126.6		

Figure 3—Pressure-Temperature Relationship of Refrigerant-134a

RELATIVE HUMIDITY	AMBIENT AIR TEMP		MAXIMUM LOW SIDE PRESSURE		ENGINE SPEED	MAXIMUM RIGHT CENTER AIR OUTLET TEMP		MAXIMUM HIGH SIDE PRESSURE	
	°F	°C	PSIG	kPaG		°F	°C	PSIG	kPaG
20	70	21	32	221	2000	43	6	175	1207
	80	27	32	221		44	7	225	1551
	90	32	32	221		50	10	275	1896
	100	38	33	228		51	11	275	1896
30	70	21	32	221	2000	45	7	190	1310
	80	27	32	221		47	8	235	1620
	90	32	34	234		54	12	290	2000
	100	38	38	262		57	14	310	2137
40	70	21	32	221	2000	46	8	210	1448
	80	27	32	221		50	10	255	1758
	90	32	37	255		57	14	305	2103
	100	38	44	303		63	17	345	2379
50	70	21	32	221	2000	48	9	225	1551
	80	27	34	234		53	12	270	1862
	90	32	41	283		60	16	325	2241
	100	38	49	338		69	21	380	2620
60	70	21	32	221	2000	50	10	240	1655
	80	27	37	255		56	13	290	2000
	90	32	44	303		63	17	340	2344
	100	38	55	379		75	24	395	2724
70	70	21	32	221	2000	52	11	255	1758
	80	27	40	276		59	15	305	2103
	90	32	48	331		67	19	355	2448
80	70	21	36	248	2000	53	12	270	1862
	80	27	43	296		62	17	320	2206
	90	32	52	356		70	21	370	2551
90	70	21	40	276	2000	55	13	285	1965
	80	27	47	324		65	18	335	2310

T2476

Figure 4—System Performance Test

If a malfunction in the refrigerant system is suspected due to abnormal system pressures, inspect the following:

1. Outer surfaces of radiator and condenser cores to be sure airflow is not blocked by dirt, leaves, or other foreign material. Be sure to check between the condenser and radiator as well as the outer surfaces.
2. Evaporator core, condenser core, hoses, tubes, etc., for restrictions or kinks.
3. Refrigerant leaks.
4. Air ducts for leaks or restrictions. Low airflow rate may indicate a restricted evaporator core.
5. Compressor clutch for slippage.
6. Drive belt for improper tension.
7. Accumulator for plugging.
8. Expansion (orifice) tube for plugging.

If the problem is not found, continue with diagnostic procedures in figures 5 through 9 for the CCOT system.

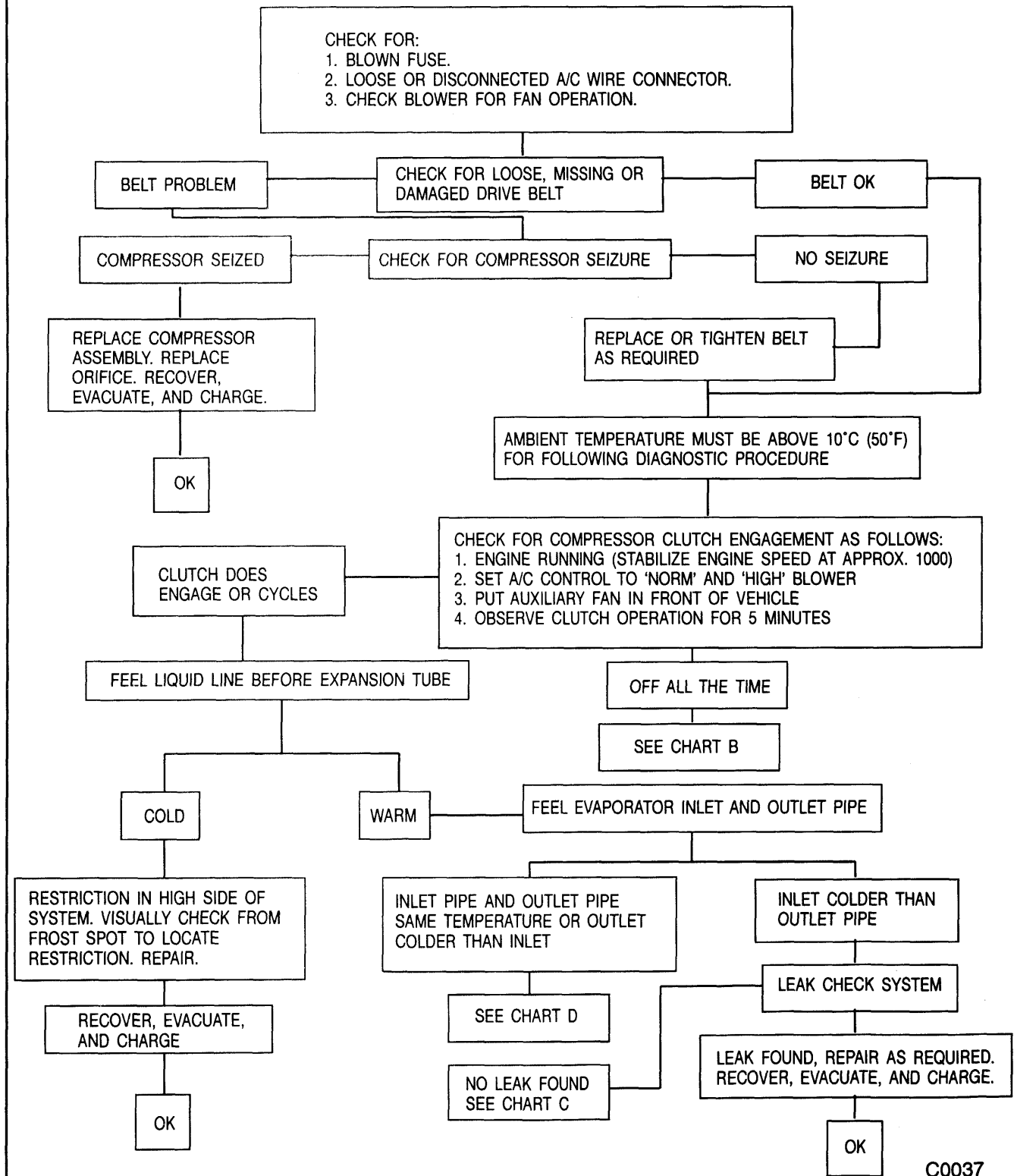
LEAK TESTING

CAUTION: Avoid breathing A/C Refrigerant-134a and lubricant vapor or mist. Exposure may irritate eyes, nose, and throat. To remove R-134a from the A/C system, use service equipment certified to meet the requirements of SAE J2210 (R-134a recycling equipment). If accidental discharge occurs, ventilate work area before resuming service. Additional health and safety information may be obtained from refrigerant and lubricant manufacturers.

A refrigerant leak test should be performed on the system whenever a leak is suspected and after performing a service operation which disturbs the components, lines, or connections. Many methods and special tools are available for this purpose; however, no matter which tool is used, care and diligence are the biggest keys to success.

1B-8 HEATER, VENTILATION, AND AIR CONDITIONING

C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSIS INSUFFICIENT COOLING "CHART A"



C0037

Figure 5—CCOT Air Conditioning System Diagnosis Procedure (1 of 5)

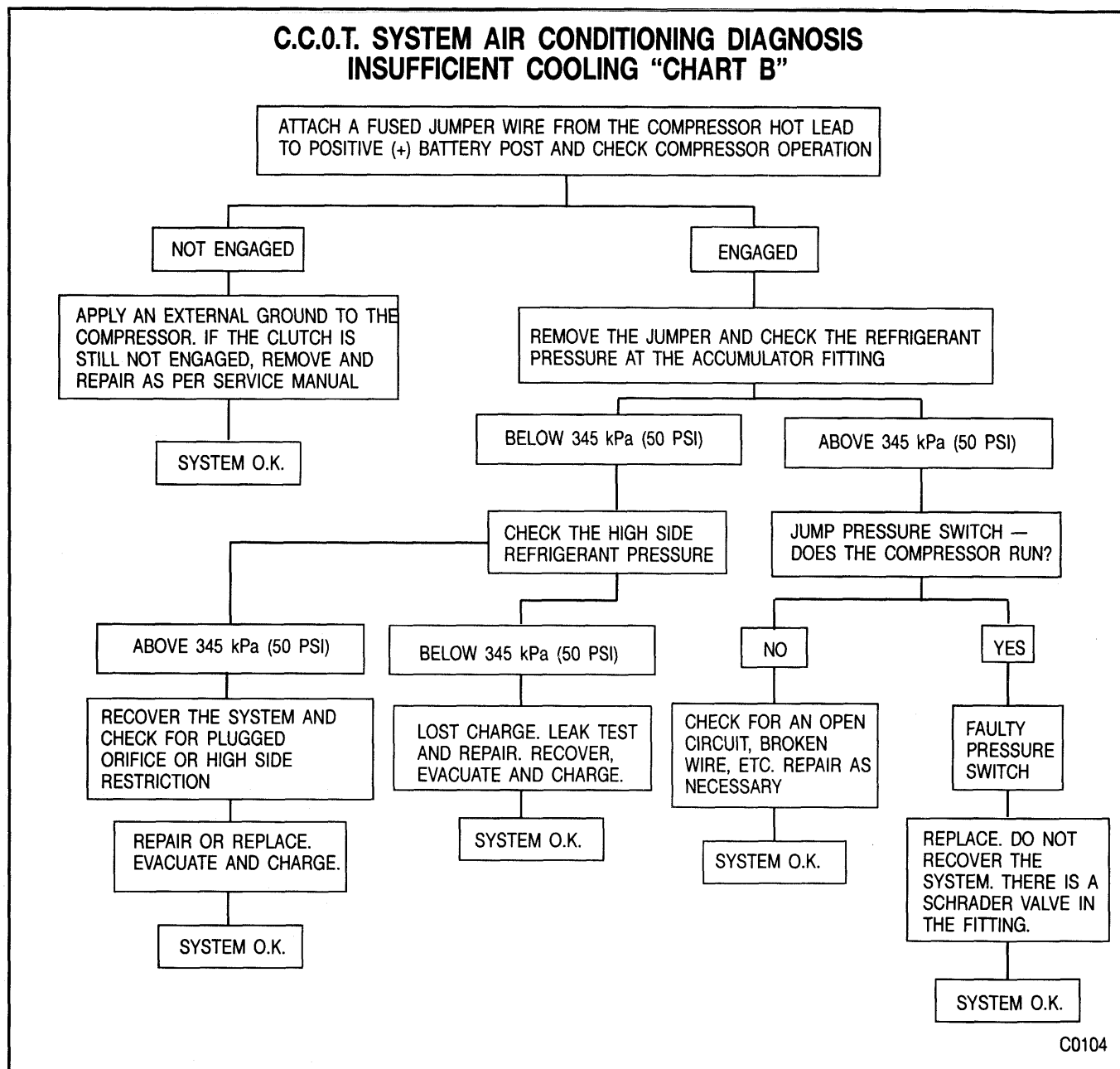


Figure 6—CCOT Air Conditioning System Diagnosis Procedure (2 of 5)

ELECTRONIC LEAK DETECTOR

Tool Required:

J 39400 Electronic Leak Detector

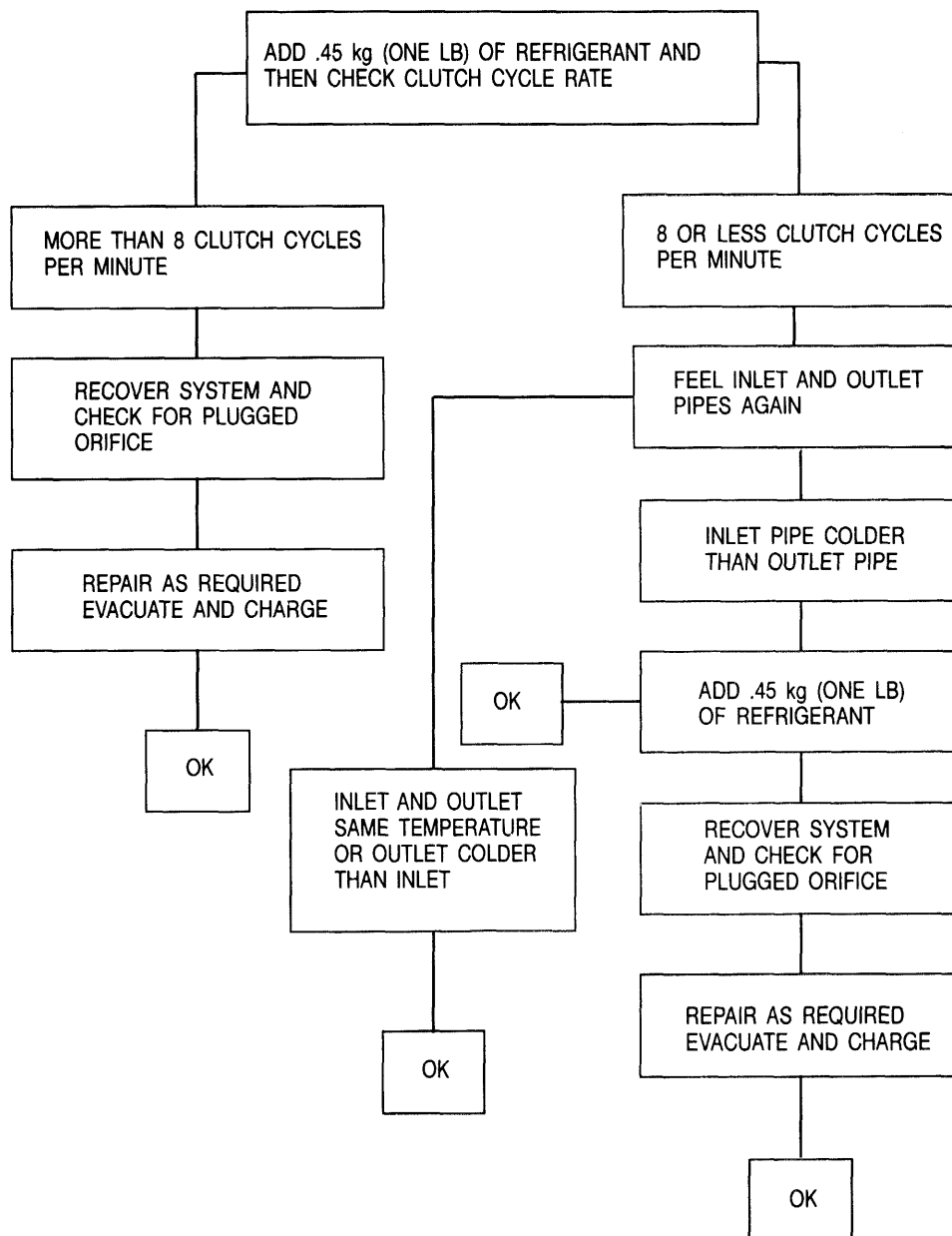
This type of leak detector has been found to be the most useful tool in locating refrigerant leaks. The J 39400 is a small unit which operates on 12V DC and provides an audible signal which increases in frequency as R-134a is detected. Make sure the instrument is properly calibrated, according to the included instructions, and that the detector is used in the proper setting for the type of refrigerant being tested. The detector "GAS" switch should be placed in "R-134a" setting prior to use (figures 10 and 11).

The most common leaks are found at the refrigerant fittings or connections. This may be caused by improper torque, damaged O-ring seals, lack of lubricant on O-ring seals, or dirt/debris across the O-ring seals.

Even the smallest piece of lint from cotton gloves or shop cloths can create a leak path across an O-ring seal.

The successful use of this and any other electronic leak detector depends greatly upon the scan rate and upon carefully following the manufacturer's instructions regarding calibration, operation, and maintenance. Each joint must be completely circled moving at 25-51 mm (1-2 inches) per second with the tip of the probe as close to the surface as possible but no more than 6 mm (0.25 inches) away and without blocking the air intake. A leak is indicated when the audible tone goes from a steady 1-2 clicks per second to a solid alarm. The balance knob should be adjusted frequently to maintain the 1-2 clicks per second rate.

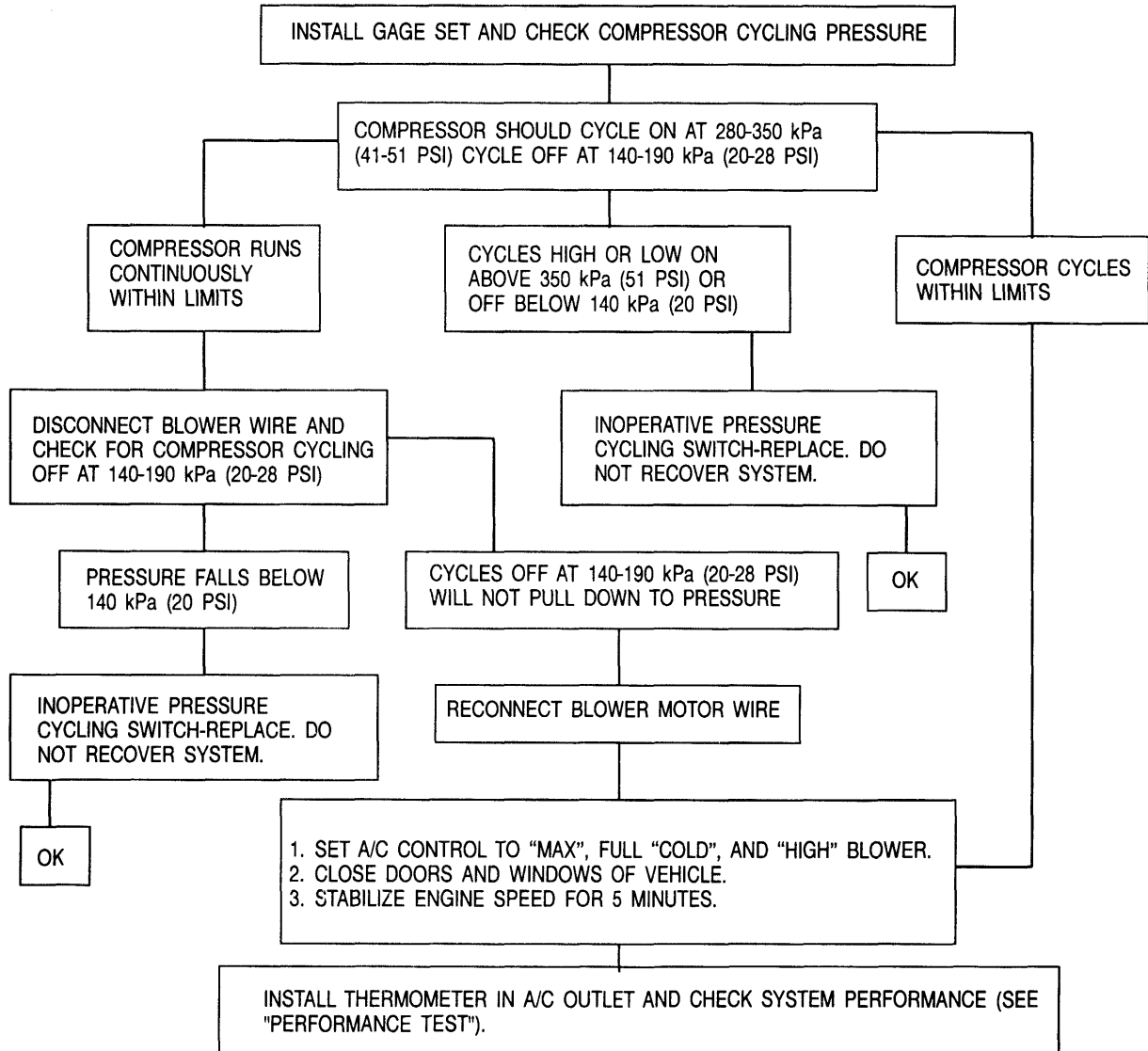
C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSTICS INSUFFICIENT COOLING "CHART C"



C0041

Figure 7—CCOT Air Conditioning System Diagnosis Procedure (3 of 5)

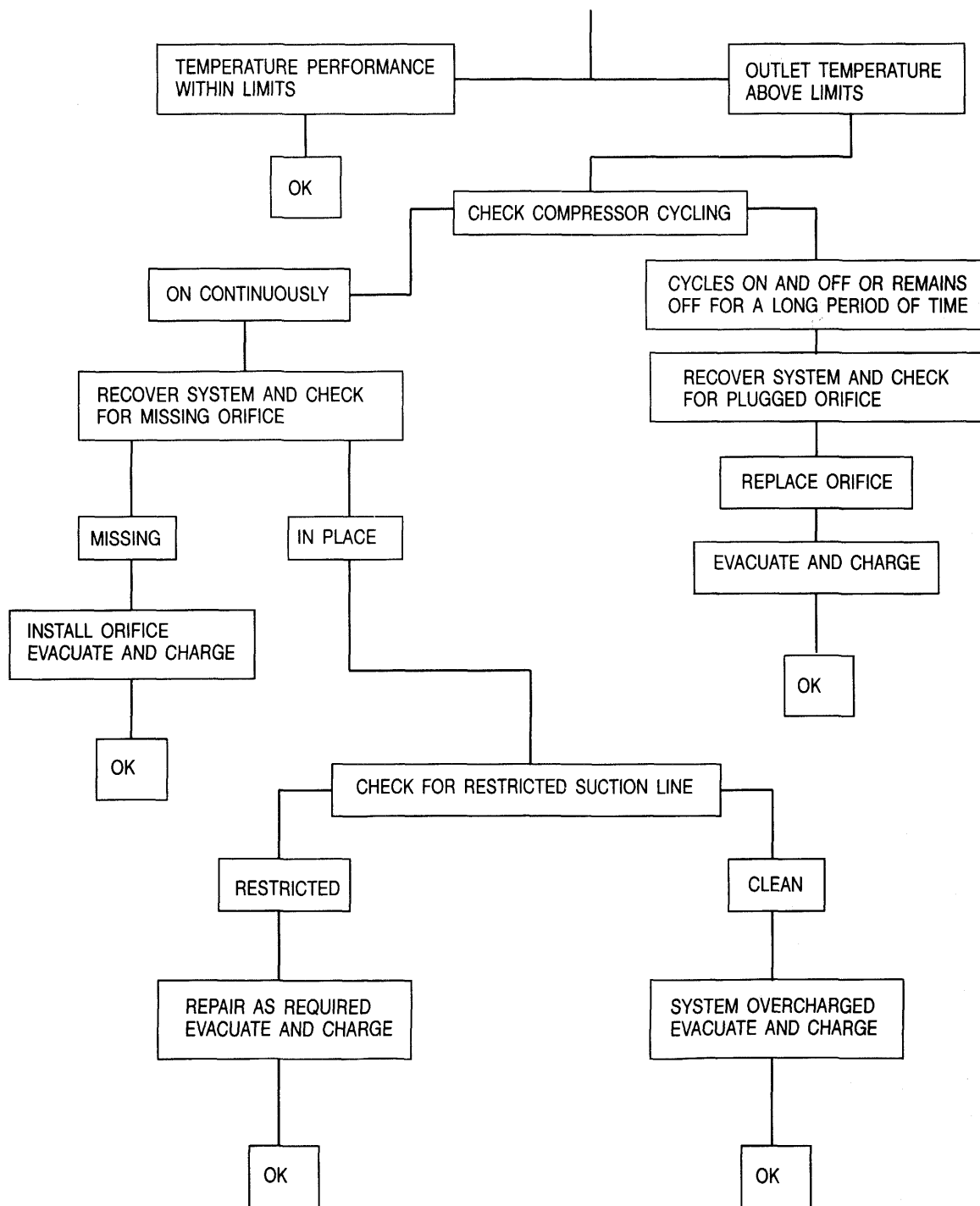
**C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSIS
INSUFFICIENT COOLING "CHART D"**



C0035

Figure 8—CCOT Air Conditioning System Diagnosis Procedure (4 of 5)

C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSIS
INSUFFICIENT COOLING "CHART E"



C0038

Figure 9—CCOT Air Conditioning System Diagnosis Procedure (5 of 5)

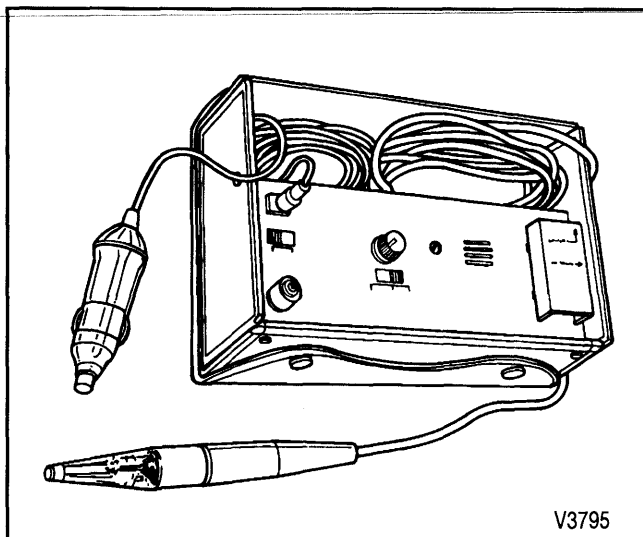


Figure 10—Electronic Leak Detector



Important

- Halogen leak detectors are sensitive to windshield washing solutions, many solvents and cleaners, and some adhesives used in the vehicle. Prevent a false warning by making sure surfaces are clean. Also, surfaces should be dry, since ingestion of liquids will damage the detector.

The evaporator inlet and outlet, accumulator inlet and outlet, condenser inlet and outlet, all brazed and welded areas, areas showing signs of damage, hose couplings, compressor rear head, and housing joints may be tested using this procedure.



Important

- Always follow the refrigerant system around in a continuous path so that no areas of potential leaks are missed. Always test all the above areas to make sure the entire system is leak free, even when one leak is already found.

CAUTION: Take care to prevent personal injury which could occur due to touching a hot engine when testing. Tests should be done with the engine "Off" and as cool as possible. Do not operate the detector in a combustible atmosphere since its sensor operates at high temperature.

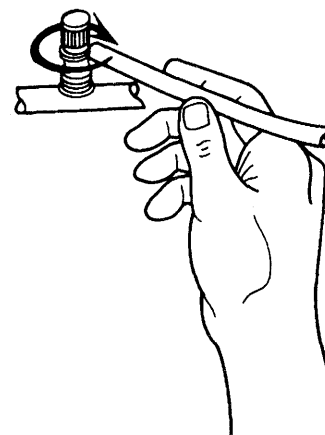
Service Ports/Access Valves

The primary seal for the service ports is the sealing cap. This cap contains a specially designed O-ring seal or gasket which provides a leak-free seal. Should the cap be loose, missing, or the wrong cap used, it will result in the loss of refrigerant charge.

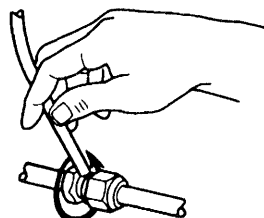
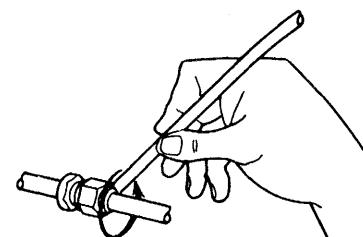
Evaporator Core

One of the most difficult leaks to find is in the evaporator core. To leak test the core:

1. Turn the blower fan on "HIGH" for 15 or more seconds then turn it off.
2. Wait 10 minutes.
3. Remove the blower motor resistor. Refer to "Blower Motor Resistor."



SCHRADER VALVE®



REFRIGERANT LINE

V3715

Figure 11—A/C Leak Scan Method

4. Insert the leak detector probe as close to the evaporator as possible. If the detector goes to a solid alarm, a leak has been found.
5. If possible, visually inspect the core face with a flashlight for evidence of refrigerant oil.

Compressor Block Fitting and Shaft Seal

1. Blow shop air behind and in front of the compressor clutch/pulley for at least 15 seconds.
2. Wait 1-2 minutes.
3. Probe the area in front of the pulley. If the detector goes to a solid alarm, a leak has been found.

CCOT AIR CONDITIONING SYSTEM DIAGNOSIS CHARTS

Refer to figures 5 through 9 for diagnosis of the CCOT air conditioning system.

BLOWER NOISE

A constant air rush noise is typical of high-speed blower operation. Some systems and modes may be noisier than others. If possible, check another similar

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vehicle to determine whether the noise is typical or excessive.

Sit in the vehicle with the doors and windows closed. With the engine running, run the blower on "HI" speed with the temperature set for maximum cooling. Cycle through the blower speeds, modes, and temperature settings to find where the noise does not occur. Try to define the types of noise.

- Noise is constant, but decreases with blower speed reduction. Typical noises are a whine, tick/click, flutter, or scrape.

- Noise is only at startup or intermittent. This noise may occur at cold ambients and low blower speeds. Typical noise is a squeal/screech.
- Noise is constant at high blower speeds in certain modes, but can be eliminated at lower blower speeds in other modes. Typical noises are a flutter or rumble.

If the noise persists, remove the blower assembly and check for obstructions or foreign material causing noise and remove. If no obstructions are found and the noise is still heard, replace the blower assembly.

DIAGNOSIS OF AIR CONDITIONING (HEATER)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Inadequate Defrosting	1. Obstruction in defroster nozzle. 2. Damaged defroster nozzle outlet. 3. Faulty defroster air valve vacuum actuator or hose. 4. Insufficient heat.	1. Both defroster nozzle outlets should be inspected. Any foreign objects should be removed. Any loose instrument panel pad that blocks an outlet should be repaired. 2. The outlet flange should be carefully reshaped with pliers so the outlet opening is uniform. If the outlet flange cannot be reshaped, the air distributor should be replaced. 3. Defroster air valve operation should be checked. A faulty vacuum actuator or hose should be replaced. 4. Refer to "Insufficient Heating of Passenger Compartment" in this chart.
Inoperative Blower	1. Blown fuse. 2. Open circuit. 3. Faulty blower switch.	1. The fuse should be replaced. 2. Check the circuit between the ignition switch and the blower motor, and the blower motor ground circuit. Repair as necessary. 3. A faulty blower switch should be replaced.
Insufficient Heating of Passenger Compartment	1. Incorrect operation of controls. 2. Low engine coolant level. 3. Faulty engine thermostat. 4. Kinked heater hose. 5. Obstructed heater core tubes. 6. Faulty blower motor or blower circuit.	1. The driver should be advised of proper operation of controls. 2. Coolant should be added as needed. A check should be made for coolant leaks. The engine should be run to clear any air locks. 3. The thermostat should be checked and replaced if necessary. 4. Hoses should be checked and kinks should be straightened or hoses replaced as necessary. 5. An obstruction usually causes a squishing noise in the core. Any foreign material should be removed from the core or the core should be replaced. 6. Faulty wires or connections must be repaired or replaced. A faulty blower motor must be replaced.

DIAGNOSIS OF AIR CONDITIONING (HEATER) (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Cold Drafts on Floor	1. Partially open air inlet valve. 2. Side door seals damaged or missing.	1. The air inlet valve should close properly in all modes except "MAX" air conditioning mode. Repairs should be made as necessary. 2. All door seals should be inspected. Faulty seals should be repaired or replaced as necessary.
D0277		

A/C ODOR DIAGNOSIS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Musty Smell	1. Water leaks (body). 2. Evaporator drain. 3. Mold/mildew.	1. Seal body. 2. Clean drain. 3. Clean evaporator.
Coolant Smell	1. Anti-freeze.	1. Heater core. 2. Heater pipe/hoses.
Refrigerant Leak	1. Refrigerant oil.	1. Evaporator core.
NOTE: MOLD/MILDEW ODOR PROBLEM — Under certain climate and operating conditions a musty odor develops from mold growth in the evaporator core face. This odor is generally temporary and as climate conditions change will disappear and repair on its own. However, if odor persists, it will become necessary to remove evaporator core and clean the face with appropriate cleaner.		
D0290		

REFRIGERATION SYSTEM SERVICES

Before attempting any service which requires opening of refrigerant lines or components, the person doing the work should be thoroughly familiar with the information under "Handling Refrigerant-134a," "Handling Refrigerant Lines and Fittings," and "Maintaining Chemical Stability." Very carefully follow the instructions in the "Refrigerant Recovery and Recycling, Adding Oil, Evacuating and Recharging Procedures" for the unit being serviced.

REPLACING O-RING SEALS

Install new GM-approved service replacement air conditioning O-ring seals whenever a joint or fitting is installed, except when the O-ring seals are provided on new replacement components. Unless service replacement O-ring seals bearing the specified part numbers are used, excessive leakage of Refrigerant-134a may occur. Refer to the part number for identification.

Air conditioning O-ring seals should be coated with 525 viscosity refrigerant oil just before installation and should be slipped onto the flange tube to ensure proper locating and sealing. To prevent the possibility of swelling and a reduction in sealing effectiveness, O-ring seals should not be soaked in refrigerant oil. Before installation, O-ring seals and fittings should be examined to make sure they have not been nicked or deformed. Replace nicked or deformed parts to prevent refrigerant leakage.

HANDLING REFRIGERANT-134a

CAUTION: Avoid breathing A/C refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose, and throat. To remove R-134a from the A/C system, use service equipment certified to meet the requirements of SAE J2210 (R-134a recycling equipment). If accidental system discharge occurs, ventilate work area before resuming service. Additional health and safety information may be obtained from refrigerant and lubricant manufacturers.



Important

- R-12 refrigerant and R-134a refrigerant must never be mixed, even in the smallest of amounts, since they are incompatible with each other. If the refrigerants are mixed, compressor failure is likely to occur.
- Use only specified lubricant (PAG) for the R-134a A/C system and R-134a components. If lubricants other than those specified are used, compressor failure is likely to occur. All fittings and O-ring seals should be coated with clean 525 viscosity refrigerant oil to provide a leak-proof seal and to aid in assembly and disassembly.

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- Do not store or heat refrigerant containers above 52°C (125°F).
- Do not heat a refrigerant container with an open flame. If the container must be warmed, place the bottom of the container in a pail of warm water.
- Do not intentionally drop, puncture, or incinerate refrigerant containers.
- Refrigerant will displace oxygen, so be certain to work in well-ventilated areas to prevent suffocation.
- Do not introduce compressed air to any refrigerant container or refrigerant component, because contamination will occur.
- If it is necessary to carry a container of "Dot CFR" Refrigerant-134a in a vehicle, do not carry it in the passenger compartment.

All Refrigerant-134a disposable (colored "Blue") containers are shipped with a heavy metal screw cap to protect the valve and safety plug of the container from damage. It is good practice to replace the cap after each use of the container to continue protection.

HANDLING OF REFRIGERANT LINES AND FITTINGS

Important

- Before opening the refrigeration system, make sure the work area is well ventilated. Welding or steam-cleaning operations should not be done on or near refrigeration system lines or other air conditioning parts on the vehicle.

All metal tubing lines should be free of dents or kinks to prevent loss of system capacity due to line restriction.

- The flexible hose lines should never be bent to a radius of less than four times the diameter of the hose.
- The flexible hose lines should never be allowed to come within a distance of 6.5 mm (2.5 inches) of the exhaust manifold.
- Flexible hose lines should be inspected regularly for leaks or brittleness and replaced with new lines if deterioration or leaking is found.
- When disconnecting any fitting in the refrigerant system, the system must be discharged of all Refrigerant-134a. However, proceed very cautiously, regardless of the gage readings. Open very slowly, keeping your face and hands away so that no injury can occur. If pressure is noticed when a fitting is loosened, allow it to bleed off very slowly.

NOTICE: *Alcohol should never be used in the refrigeration system in an attempt to remove moisture. Damage to system components could occur.*

- If any refrigerant line is opened to the atmosphere, it should be immediately capped to prevent the entrance of moisture and dirt. These can cause internal compressor wear or plugged lines in the condenser and evaporator core and expansion (orifice) tubes or compressor inlet screens.

- Remove sealing caps from subassemblies just before making connections for final assembly. Use a small amount of clean 525 viscosity refrigerant oil on all tube and hose joints. Use new O-ring seals dipped in 525 viscosity refrigerant oil when assembling joints. The oil will aid in assembly and help to provide a leakproof joint. O-ring seals and seats must be in perfect condition because a burr or a piece of dirt can cause a refrigerant leak.
- It is important to use the proper wrenches when making connections on O-ring seal fittings. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connecting lines or components. When connecting the flexible hose connections, it is important that the swaged fitting and the flare nut, as well as the coupling to which it is attached, be held at the same time using three different wrenches to prevent turning the fitting and damaging the seat (figure 12).

Tighten tubing connections to the specified torque, refer to "Specifications."

MAINTAINING CHEMICAL STABILITY

The life and efficient operation of the air conditioning system depends upon the chemical stability of the refrigerant system. When foreign materials, such as dirt, air, or moisture, contaminate the refrigeration system, they change the stability of the Refrigerant-134a and polyalkaline glycol (PAG) refrigerant oil. They will also affect the pressure-temperature relationship, reduce efficiency, and could cause internal corrosion and abnormal wear of moving parts.

The following general practices should be followed to ensure chemical stability in the system:

1. Whenever it becomes necessary to disconnect a hose connection, wipe away any dirt or oil at or near the connection to eliminate the possibility of dirt entering the system. Both sides of the connection should be capped, plugged, or taped as soon as possible to prevent the entrance of dirt and moisture. (Remember that all air contains moisture. Air that enters any part of the refrigeration system will carry moisture with it, and the exposed surfaces will collect the moisture quickly.)
2. Keep tools clean and dry. This includes the Manifold Gage Set and all replacement parts.
3. When adding polyalkaline glycol (PAG) refrigerant oil, the container/transfer tube through which the oil will flow should be exceptionally clean and dry. Refrigerant oil must be as moisture-free as possible.
4. When it is necessary to "open" an air conditioning system, have everything needed ready so that as little time as possible will be required to perform the operation. Do not leave the air conditioning system open any longer than necessary.
5. Anytime the air conditioning system has been "opened," it should properly be evacuated before recharging.

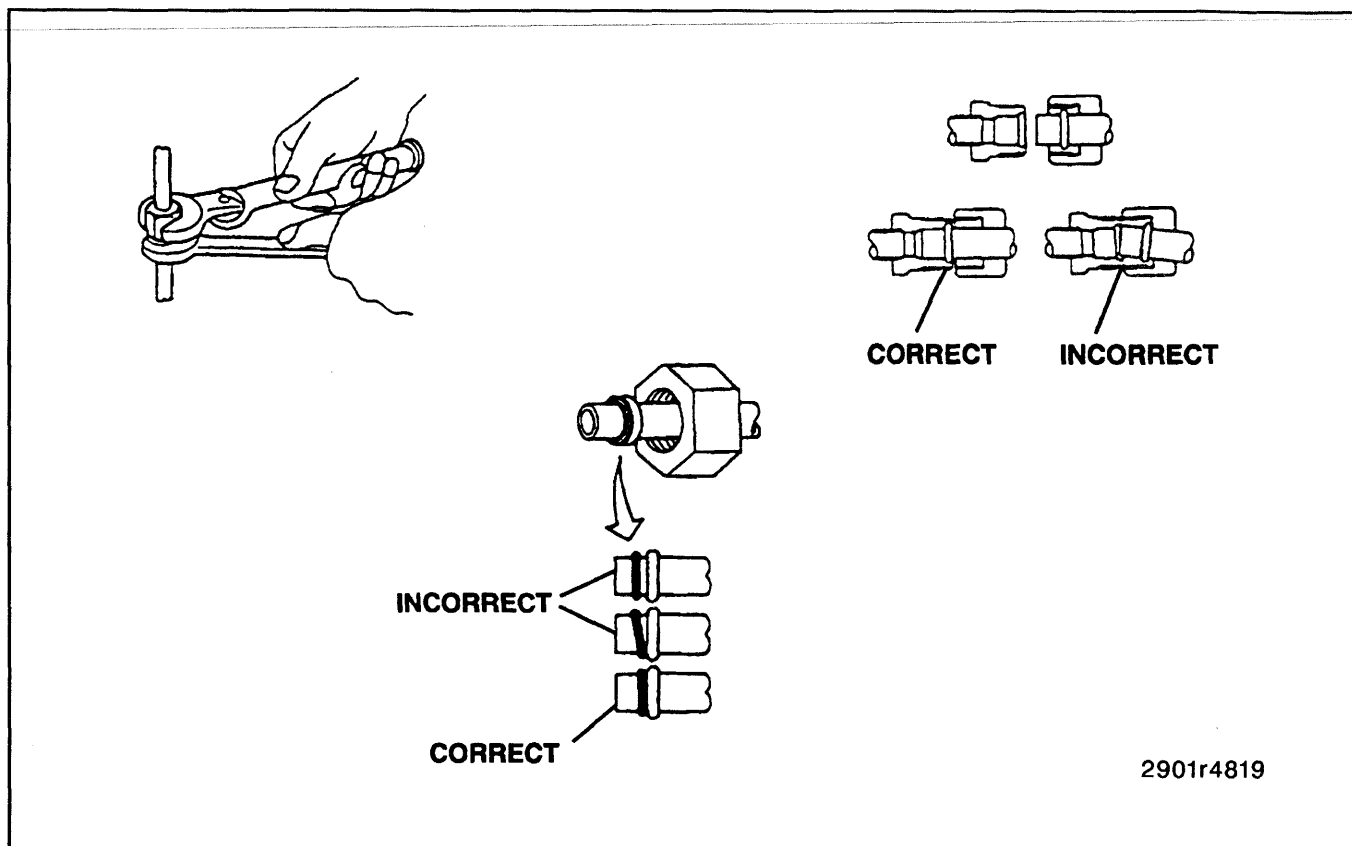


Figure 12—Refrigerant Lines and Fittings

REFRIGERANT AND OIL CAPACITY

The refrigerant system requires refrigerant and oil in the quantities listed below:

1. Refrigerant-134a

- Pickup Models - 0.91 kg (2.0 lb.)
- Crew Cab, Suburban, and Utility Models - 1.02 kg (2.25 lb.)
- Suburban Models with Aux. A/C - 1.81 kg (4.0 lb.)

2. Polyalkaline Glycol (PAG) Refrigerant Oil

- Front Air Conditioning System (C60) - 240 ml (8 fl. oz.).
- Front and Rear Air Conditioning System (C69) - 330 ml (11 fl. oz.).
- Overcharging a system may allow liquid Refrigerant-134a to get into the compressor, causing compressor noise and damage. Undercharging will cause insufficient cooling.

REFRIGERANT RECOVERY AND RECYCLING, ADDING OIL, EVACUATING AND RECHARGING PROCEDURES

GENERAL DESCRIPTION

The air conditioning refrigerant (R-134a) recovery, recycling and recharging system (J 39500) removes Refrigerant-134a from the vehicle A/C system, recycles and recharges all with one hookup.

Single-pass filtering during recovery cycle, plus automatic multiple-pass filtering during evacuation cycle

ensures a constant supply of clean/dry refrigerant for A/C system charging.



Important

- R-12 and R-134a require separate and non-interchangeable sets of recovery, recycle, and recharge equipment, because the refrigerants

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and lubricants are not compatible and cannot be mixed even in the smallest amounts.

- Do not attempt to use one set of equipment for both R-12 and R-134a, as all equipment contains residual amounts of refrigerant and/or lubricant, which will result in contamination and damage to the recover/recycle equipment.
- Adaptors to convert from one size fitting to the other must never be used; refrigerant/lubricant contamination will occur and system failure may result.

STATION (ACR⁴) SETUP AND MAINTENANCE

Initial Setup

Refer to the manufacturer's instructions for all initial setup procedures.

Operational Setup

CAUTION: Always wear goggles and gloves when doing work that involves opening the refrigeration system. If liquid refrigerant comes into contact with the skin or eyes, injury may result.

CAUTION: Use only authorized 23-kg (50-lb.) refillable refrigerant tanks (J 39500-50). Use of other tanks could cause personal injury and void the warranty.

1. Connect high side (Red) and low side (Blue) hoses to the ACR⁴ unit (figure 13). Be sure to route hoses through hose reel bracket grommets.



Important

NOTICE: Refrigerant-134a systems have special fittings (per SAE specifications) to avoid cross-contamination with Refrigerant-12 systems. Do not attempt to adapt this unit to Refrigerant-12 systems as severe system failure will result.

CONTROL PANEL FUNCTIONS

This section explains the functions of the various components of the unit's control panel (figure 14).

- **Main Power Switch**--Supplies electrical power to the control panel.
- **Beeper**--Emits an audible tone to alert the operator to unit operating functions.
- **Digital Display**--Shows the time programmed for vacuum and the weight of refrigerant programmed for recharging. Detailed instructions for programming this display are included in "Digital Display Functions" in this section.
- **Low Side Manifold Gage**--When connected to an A/C system, this gage shows the system's low side pressure.
- **High Side Manifold Gage**--When connected to an A/C system, this gage shows the system's high side pressure.
- **Moisture Indicator**--Shows if the refrigerant is wet or dry.
- **Low Side Valve**--Connects the the low side of the A/C system to the unit.

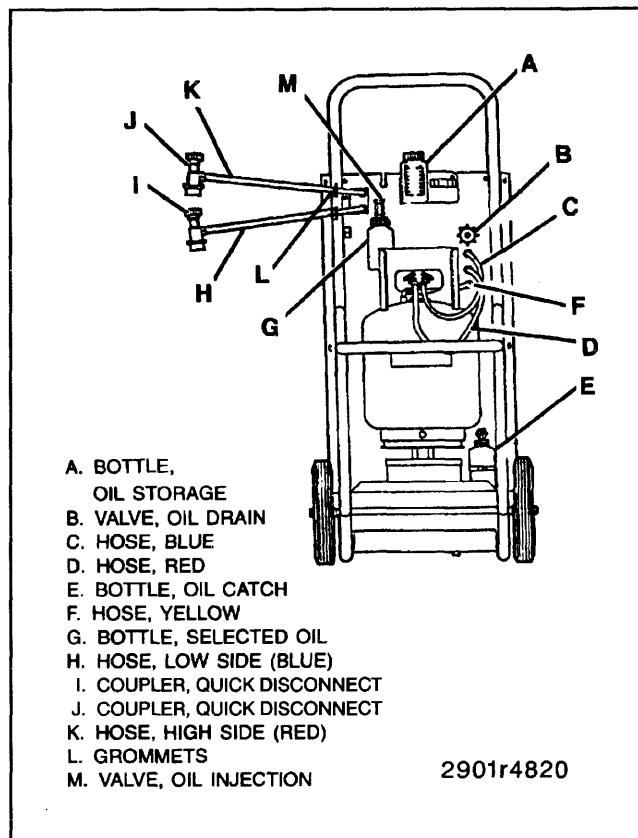


Figure 13—Complete Operational Set-Up

- **High Side Valve**--Connects the high side of the A/C system to the unit.

In addition to the number keys, the control panel contains special keys that accomplish specific operating functions (figure 15).

- **RECYCLE**--Activates the recycling sequence.
- **RECOVER**--Activates the recovery sequence.
- **SHIFT/RESET**--Activates "shifted" positions of keys on the keypad and resets the program mode.
- **FILTER**--Automatically recovers and evacuates to 17 in. Hg. from the filter and low side of the unit.
- **CHG.**--Automatically charges the A/C system with the programmed amount of refrigerant.
- **HOLD/CONT.**--Interrupts the automatic cycle in the "HOLD" position, and then resumes functions in the "CONT" position. Press this button once for "HOLD," and again for "CONT."
- **VACUUM**--Activates the vacuum and automatic recycling sequence.
- **ENTER**--Enters programmed data into the unit's control memory.

Digital Display Functions

For information regarding the functions of the digital display, refer to the manufacturer's instructions.

MAINTENANCE

Refer to manufacturer's instructions for all maintenance procedures.

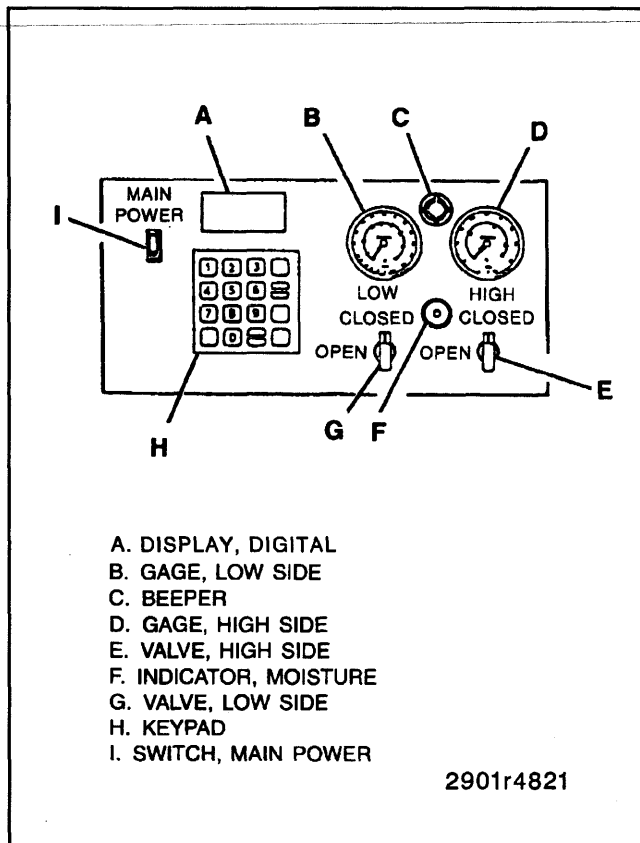


Figure 14—Control Panel

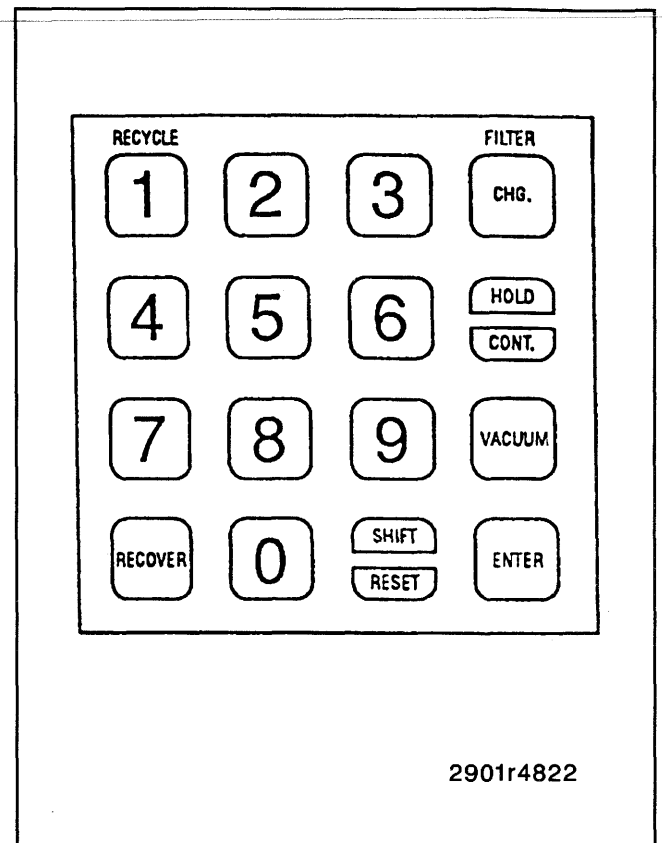


Figure 15—Keypad Functions

REFRIGERANT RECOVERY

! Important

- Use only the 23-kg (50-lb.) unit refrigerant tank (J 39500-50) designed for the ACR⁴. The unit's overfill limitation mechanism has been calibrated specifically for use with this tank, and the tank's valving is set up specifically for use with the unit.
1. Attach the high side (Red) hose with the quick disconnect coupler to the high side fitting of the vehicle's A/C system. Open the coupler valve after attachment.
 2. Attach the low side (Blue) hose with the quick disconnect coupler to the low side fitting of the vehicle's A/C system. Open the coupler valve after attachment.
 3. Check the high side and low side gages on the unit's control panel to be sure the A/C system has pressure. If there is no pressure, there is no refrigerant in the system to recover.

! Important

- If there is no refrigerant in the A/C system, do not continue with the recovery operation. Air will be drawn into the recovery tank.
4. Open both the high side (E) and the low side (G) valves on the control panel (figure 14).
 5. Open both the red "Gas" (vapor) and the blue "Liquid" valves on the tank.

6. Slowly open the oil drain valve (B) to see if the oil separator contains oil (figure 13).
 - If any oil drains into the catch bottle at the bottom of the unit, allow it to drain until there is no more oil in the separator.
7. Close the oil drain valve.
 - Dispose of the oil in the catch bottle in an appropriate manner and return the bottle to its place on the unit.
8. Plug the unit into the proper voltage outlet and turn on the "Main Power" switch.
9. Press "RECOVER" on the key pad. Before recovery begins, the unit will clear itself of refrigerant. "CL-L" will appear on the display. The clearing process takes from 30 seconds to 3 minutes to complete (figure 16).
10. When clearing is complete, the unit will automatically start recovery, and the control panel display will show the unit is in the "Recover" mode of the "Automatic" cycle. Also, the weight of refrigerant being recovered will be displayed.
11. The compressor shuts off automatically when initial recovery has occurred (at approximately 17 in. Hg. vacuum).
12. At the end of the initial recovery process, the display shows "CPL" and then alternately flashes the weight of refrigerant recovered and "OIL/OZ." ("OIL/GMS").

Note: After the initial recovery, more refrigerant might be trapped in the system. About 5 minutes is usually required for it to boil out of the oil. Follow step 17 to continue the recovery process.

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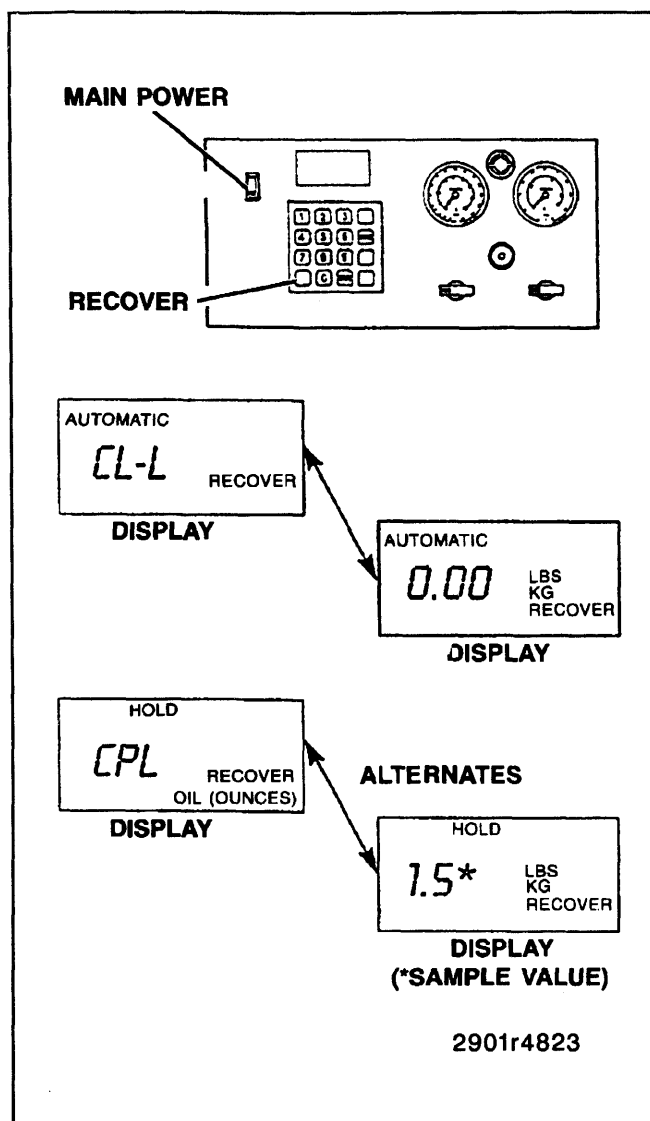


Figure 16—Refrigerant Recovery

! Important

- Some A/C system lubricating oil (Polyalkaline Glycol-PAG) might be removed with the refrigerant during recovery. The amount of oil removed (often there will be none) will vary greatly depending on a variety of conditions of the vehicle being serviced. The ACR⁴ separates the oil from the refrigerant.
 - The "OIL/OZ" ("OIL/GMS") flashing is a reminder to always drain the recovered oil at this time. The same amount of oil must be replaced in the A/C system later when the system is recharged with refrigerant.
13. Slowly open the oil drain valve (B) and drain the oil into the calibrated oil catch bottle (E) at the bottom of the unit (figure 13).
 14. After the oil is completely drained, close the valve.
 15. Read and record the amount of oil removed in the catch bottle.
 16. Dispose of the recovered oil in an appropriate manner. Never reuse this oil.

17. Wait 5 minutes, then check the control panel "Low Side Gage."

- If the A/C system has maintained a vacuum, the recovery is complete.

18. If the "Low Side Gage" pressure rises above "0," this indicates the presence of more refrigerant in the system. In this case, press the "HOLD/CONT" key on the keypad to recover the additional refrigerant. Repeat this step as needed until the system maintains vacuum for 2 minutes.

! Important

- If the display flashes "Full" during the recovery process, and the unit shuts off, the unit tank is full.
- An empty unit tank (J 39500-50) must be installed to accommodate additional refrigerant proceeding to the next step in the recovery operation. DO NOT USE ANY OTHER KIND OF TANK.
- It is possible to lower the amount of refrigerant in the unit's tank by charging other vehicles.

EVACUATION

The ACR⁴ unit tank must contain sufficient R-134a refrigerant for A/C system charging. Check the amount of refrigerant in the tank by simultaneously pressing "RESET" and "ENTER" on the keypad to enter the diagnostic mode. Once in the diagnostic mode, press "7." When "7" is pressed, the ACR⁴ unit will display the amount of R-134a refrigerant available in the tank. If less than 3.6 kg (8 lbs.) is displayed, add new refrigerant to the tank. Refer to the manufacturer's instructions for adding refrigerant.

1. With the high side and low side hoses connected to the vehicle A/C system, open both the high side (Red) and the low side (Blue) valves on the unit's control panel.
2. Open both the red "Gas"(vapor) and the blue "Liquid" valves on the tank.

! Important

- To remove all the air and properly dry the A/C system, the unit automatically goes to a minimum evacuation time of 20 minutes.

It is possible to evacuate longer than 20 minutes. Press keys to enter time desired. New entry will show on the display. Press "ENTER" and the display will blink indicating input of data (figure 17).

3. Press "VACUUM" to start the vacuum pump. The display counts down the vacuum time from 20 minutes to zero to indicate operation time remaining. The display reads "RECYCLE" 5 seconds after the vacuum pump starts and continues while the process takes place.

! Important

- Automatic refrigerant recycling during each evacuation is a feature of the ACR⁴ system. No action is required by the technician.

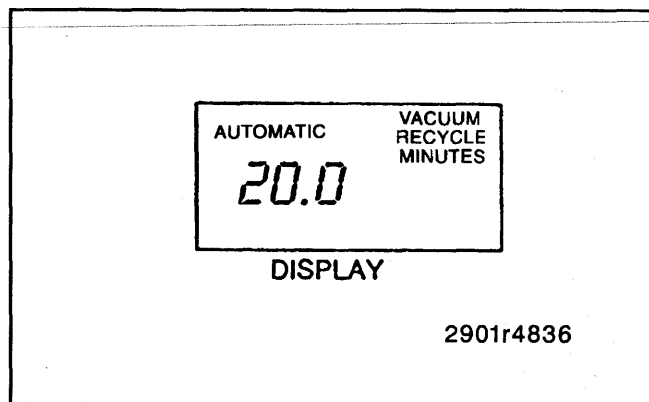


Figure 17—System Evacuation

- The control panel "Moisture Indicator" must be "Green" during recycling verifying refrigerant moisture content is within specification. "Yellow" indicates a wet condition requiring a filter/drier cartridge change. Refer to the manufacturer's instructions for this procedure.
 - Non-condensable gases (mostly air) are automatically vented from the tank during the recycling process. An audible sound of pressure release may be heard as this happens. This is a normal function.
4. At approximately the 17 minute mark on the display, (pump has run for 3 minutes) press "HOLD/CONT" key to stop vacuum pump (figure 18).
 - A. A "0" vacuum reading indicates a major system leak. Repair leak and restart evacuation procedure.
 - B. If a reading of 91-101 kPa (27-30 inch of Hg) is indicated, close the low side and high side valves. Observe the vacuum level for a few minutes as a leak check of the A/C system. If vacuum is not maintained, find and repair the A/C system leak before continuing.
 - C. If a reading of 91-101 kPa (27-30 inch of Hg) is maintained, open the high side and low side valves and press the "HOLD/CONT" key to restart the vacuum pump.
 5. When the vacuum sequence has run the programmed time, the display shows "CPL" to indicate that evacuation is complete.

! Important

- The vacuum pump oil must be changed frequently.
- When the pump has run for a total time of 10 hours, the message "OIL" will flash on the control panel display as a reminder to change the oil.
- If the "OIL" warning flashes during operation, press "CONT" and change the oil before the next operation. Refer to the manufacturer's instructions for this procedure.

A/C SYSTEM OIL CHARGE REPLENISHING

If oil was removed from the A/C system during the recovery process, it must be replenished at this time.

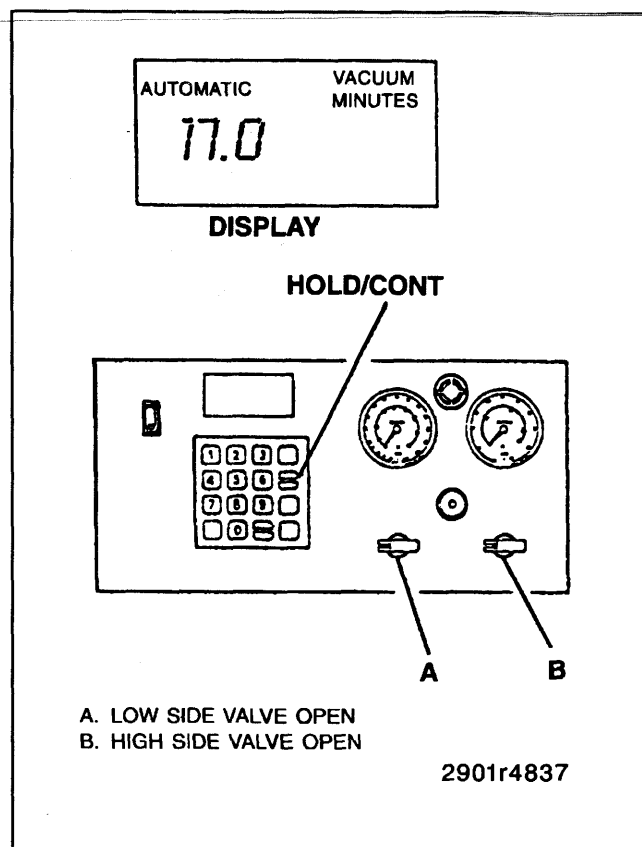


Figure 18—System Evacuation

1. Select the correct graduated bottle of replenishing polyalkaline glycol (PAG) oil for the R-134a A/C system being serviced.
2. Adjust the O-ring seal around the the PAG oil bottle to the required oil charge level.
Example: If bottle oil level is at 4 oz. and 1/2 oz. of oil is required, adjust O-ring seal to 3 1/2 oz. as final level mark.
3. Install the bottle on the oil injection system on the back of the unit.

! Important

- Keep the oil bottles tightly capped at all times to keep out moisture and contamination.
 - Never open the oil injection valve while there is positive pressure in the A/C system. This will result in oil blow-back through the bottle vent. A/C system vacuum is required for this operation.
 - Never let the oil level drop below the pickup tube while charging or replenishing. This will allow air into the A/C system.
4. Open the valve at the top of the plastic container and watch the level of oil being drawn into the system.
 5. Close the valve when the required oil charge has been pulled into the system.

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REFRIGERANT OIL DISTRIBUTION

The Harrison HR110-MD compressor system used on all C/K models requires polyalkaline glycol (PAG) refrigerant oil in the quantities listed below:

- Without Aux. A/C - 240 ml (8 fl. oz.)
- With Aux. A/C - 330 ml (11 fl. oz.)

New oil quantities must be added to the system during component replacement and conditions stated as follows:

- With no signs of excessive oil leakage, add:
 - A. All Compressors (drain and measure the oil)
 - If less than 30 ml (1 fl. oz.) is drained—add 60 ml (2 fl. oz.) to the new compressor.
 - If more than 30 ml (1 fl. oz.) is drained—add same amount that was drained to the new compressor.
 - B. Accumulator—Add 105 ml (3.5 fl. oz.) of new oil to the replacement accumulator to compensate for oil retained by original accumulator desiccant and bag assemblies. The accumulator should only be replaced if leaking due to a perforation, damaged O-ring seal seat, or damaged threads.
 - C. Evaporator—Add 90 ml (3 fl. oz.) of new refrigerant oil.
 - D. Condenser—Add 30 ml (1 fl. oz.) of new refrigerant oil.

Refrigerant Oil Loss Due to a Large Leak

If the refrigerant charge is abruptly lost due to a large refrigerant leak, approximately 90 ml (3 fl. oz.) of refrigerant oil will be carried out of the system suspended in the refrigerant. Any failure that caused a abrupt refrigerant discharge will experience this oil loss. Failures that allow the refrigerant to seep or bleed off over time do not experience this oil loss.

Upon replacement of a component which caused a large refrigerant leak, add 90 ml (3 fl. oz.) of new polyalkaline glycol (PAG) refrigerant oil plus the desired amount of oil for the particular component. Refer to "Refrigerant Oil Distribution."

CHARGING

! Important

- The A/C system must be evacuated prior to charging.
- Check that the "Lbs/Kg" switch on the back of the unit to be sure it is set for the desired units of weight system (operate switch with main power "Off").

1. Close the low side valve (A) on the control panel (figure 19).
2. Open the high side valve (B) on the control panel.
3. Press "CHG" on the keypad to be sure the unit is in the program mode.
4. Enter the amount of refrigerant charge to charge the A/C system by pressing the appropriate number keys. Be sure to use correct unit of weight (Lbs. or Kg.).
5. Press "ENTER."
 - A blink of the display indicates the charge amount is in the unit's memory.

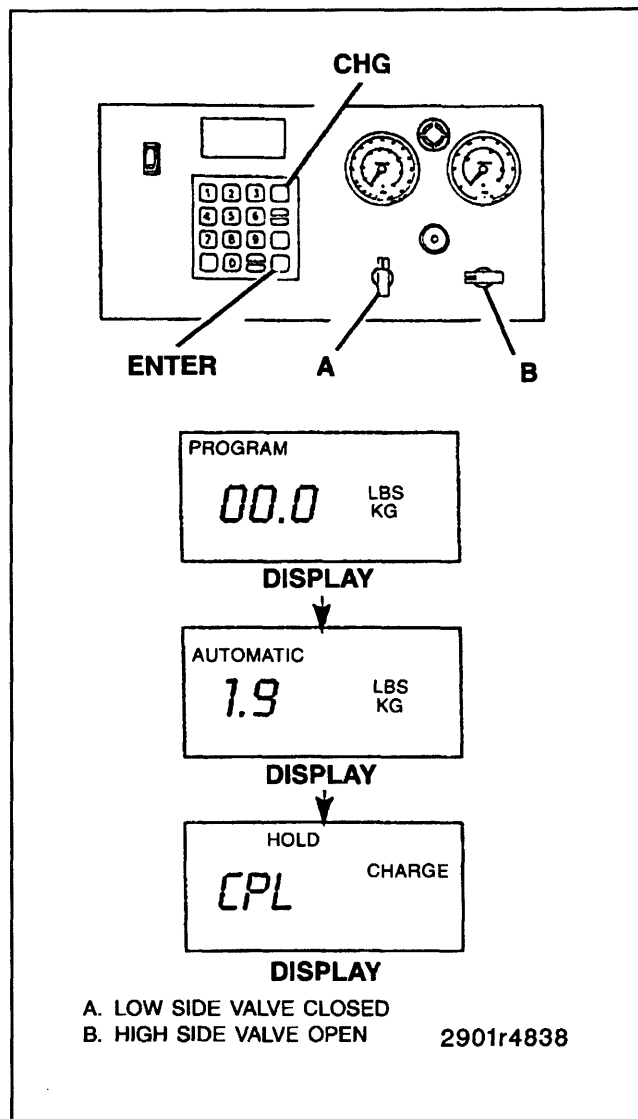


Figure 19—System Charging

6. Press "CHG" on the keyboard to begin the charging process.
7. The display shows "AUTOMATIC" and the amount of refrigerant programmed for charging.
 - The display counts down to zero as the charging process proceeds.
 - At the end of the process, the display shows "CPL."

! Important

- If the transfer of refrigerant stops before complete, refer to "Unsuccessful Transfer."

Successful Transfer Complete

1. Close the high side valve on the unit's control panel. (Both valves should be closed.)
2. Start the vehicle and the A/C system and let run until the readings on the high side and low side gages stabilize. Compare readings to system specifications.
3. Check the evaporator outlet temperature to be sure the A/C system is operating to system specifications.

4. With the A/C system running, close the high side coupler valve (J) and disconnect the high side (Red) hose (K) from the vehicle.
5. Open both the high side and low side valves on the control panel.
6. Refrigerant from both hoses will be drawn quickly in to the A/C system through the low side (Blue) hose.
7. Close the low side coupler valve and disconnect from the vehicle.

Unsuccessful Transfer

On rare occasions, the total charge does not transfer to the vehicle A/C system. There are two reasons why this can occur.

1. If the transfer is too slow because the pressure in the unit's tank and the vehicle A/C system are about the same, the unit will emit an audible signal and the display shows the weight remaining for transfer.

In this case:

- Close the high side valve (B) (figure 20).
- Open the low side valve (C) (figure 20).
- Start the vehicle A/C system, and press "HOLD/CONT" on the keypad.

This will put the remainder of the charge into the A/C system, and continue with Step 1 under "Successful Transfer Complete."

2. If the transfer will not complete and the display shows "CHECK REFRIGERANT," there is not enough refrigerant in the tank to complete the process. This condition requires the recovery of the partial charge of refrigerant in the vehicle A/C system and another complete evacuation and charge procedure.

- Press "HOLD/CONT" on the keypad to interrupt the cycle.
- Press "RESET" to reset the unit.

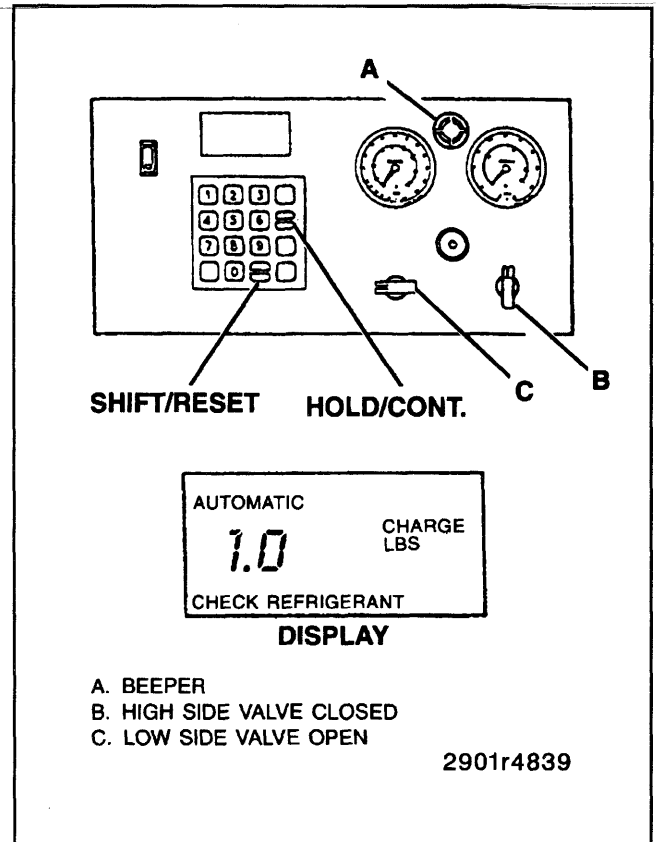


Figure 20—System Charging

- Recover the refrigerant that has been charged into the system, refer to "Refrigerant Recovery."
3. Add refrigerant to the tank following the manufacturer's instructions, and refer to Step 1 under "Evacuation."

DIAGNOSIS OF THE REFRIGERANT RECOVERY, RECYCLING AND RECHARGING SYSTEM

PROBLEM	POSSIBLE CAUSE	CORRECTION
RECOVERY OPERATION		
Recovery Compressor Does Not Start	• "Main Power" switch off. • Power cord not plugged in or no power at plug. • "Full" on digital display. • "Hi-P" on digital display. • Faulty components.	• Turn on "Main Power" switch. • Check circuit for power. • Change the tank according to the manufacturer's instructions. • Check the valves on the unit tank to be sure they are open. • Operate recycling only to activate automatic air purge. Excessive air raises the tank pressure. Refer to manufacturer's instructions. • Call Tech Assist 1-800-345-2233.
Runs A Short Time, But Does Not Complete Recovery	• Tank valves not open. • Manifold valves not open. • Faulty components.	• Open both valves on the tank. • Open both valves on the manifold. • Call Tech Assist 1-800-345-2233.

DIAGNOSIS OF THE REFRIGERANT RECOVERY, RECYCLING AND RECHARGING SYSTEM (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Runs But Won't Shut Off	• Oil drain valve not closed. • Leak in vehicle system. • Return oil solenoid valve open. • Faulty components.	• Close the oil drain valve. • Locate and repair system leak. • Replace solenoid valve. • Call Tech Assist 1-800-345-2233.
RECYCLING OPERATION		
Moisture Indicator Will Not Turn Green During Automatic Recycling (Occurs During A/C System Evacuation)	• Saturated filter-drier. • Faulty moisture indicator.	• Remove and replace filter-drier following manufacturer's instructions. • Remove and replace the moisture indicator.
Refrigerant Does Not Flow During Recycling	• Refrigerant supply empty or low. • Faulty moisture indicator.	• Check display for "CHECK REFRIGERANT". If shown, add more refrigerant before recycling. Refer to manufacturer's instructions. • Open the valves.
No Power When POWER Switch Is On—No Display Showing	• Unit unplugged. • No power at wall outlet.	• Plug unit into power source outlet. • Locate problem with outlet or change outlets.
Vacuum Pump Does Not Start	• Vacuum pump unplugged. • Check extension cord (if used). • Faulty components.	• Plug pump into power source. • Try without extension cord. • Call Tech Assist 1-800-345-2233.
Audible Tone Sounds During Refrigerant Transfer	• Transfer stopped or too slow. • Refrigerant supply low.	• Start vehicle A/C system and pull rest of refrigerant into system. • Add refrigerant to the tank. Refer to manufacturer's instructions.
Vacuum Pump Runs, But Low Side Gauge Does Not Register An Appropriate Vacuum	• Low side valve closed. • Pump oil contaminated. • Charging line loose. • Manifold leaking.	• Open low side valve. • Change oil. Refer to manufacturer's instructions. • Check connections. • Check connections.
D0289		

AIR CONDITIONING SYSTEM ODOR PROCEDURE

Odors emitted from the air conditioning system primarily at startup in hot, humid climates. This odor may be the result of debris in the heater/evaporator case or growth of mold on the evaporator core. To address this condition, use the following equipment and procedure.

Tools Required:

J 36645 Air Conditioning Cleaning Gun
GM Goodwrench Air Conditioning System Disinfectant Kit

CAUTION: Procedure should only be performed on a cold vehicle to prevent the disinfectant from coming in contact with hot engine components. Disinfectant can cause substantial but temporary eye injury. Do not get in eyes or clothing. Wash thoroughly with soap and water after handling.



Important

- If disinfectant gets into eyes, hold eyelids open and flush with a steady, gentle stream of water for 15 minutes. Obtain medical attention if irritation persists.

1. Put on rubber gloves and safety goggles.
2. Pour the small bottle of the two-part GM Goodwrench Air Conditioning System Disinfectant Kit into the large bottle. Seal and invert the large container once or twice to mix contents.
3. Check underneath the vehicle to verify that drain outlet is not plugged.
4. Connect battery charger to avoid draining the battery during cleaning procedure.
5. Remove blower resistor, leaving wiring connectors attached. Refer to "Blower Motor Resistor."

NOTICE: Do not allow the metal coils of the blower resistor to become grounded to any metal surface as this may result in internal circuitry damage.

6. Check heater/evaporator case for debris. Remove any debris present through blower resistor opening. If debris is imbedded into the evaporator core face and cannot be removed, the core will have to be removed from the vehicle and cleaned. If a large amount of debris is present in the heater/evaporator case the air inlet screen will require sealing around the air intake in the cowl area.
7. Turn the ignition to the "ON" position but do not start vehicle.
8. Set mode selector to "Vent," blower speed to "LOW," and temperature to full "COLD."
9. Open all windows and doors. Exit vehicle.
10. Place a drain pan with at least a 2-quart capacity below heater/evaporator drain hole to collect disinfectant and rinse water runoff. If necessary, install additional hose onto drain so that all fluid goes into the drain pan.

11. Turn pedestal fan on "High" to provide cross ventilation during cleaning procedure.
12. Using J 36645, or equivalent spray gun, insert the nozzle of the spray gun through the blower resistor opening and insert siphon hose into container of disinfectant. Spray directly toward evaporator face taking extra care to ensure adequate coverage of the corner and edges, completely saturating the entire core. Use the entire container of solution.



Important

- Do not allow disinfectant to come into contact with hot engine components such as the exhaust manifold.
13. Reach into vehicle and turn the ignition to the "OFF" position, and allow the core to soak for 5 minutes.
 14. Double check underneath the vehicle to verify proper drain operation. If necessary, unclog and increase drain plug slits with a razor blade or sharp knife.
 15. Reach into the vehicle and turn the ignition to the "ON" position, but do not start vehicle.
 16. Thoroughly rinse the evaporator core with clean water using the spray gun to remove all disinfectant residue. At least a 2-quart rinse is recommended.
 17. Reach into the vehicle and turn the ignition to the "OFF" position and then reinstall the blower resistor. Refer to "Blower Motor Resistor."
 18. Dispose of disinfectant properly and rinse water runoff collected in the drain pan in an approved manner.

ON-VEHICLE SERVICE

COMPRESSOR

4.3L, 5.0L and 5.7L ENGINES



Remove or Disconnect (Figure 21)

1. Negative battery cable. Refer to SECTION 0A.
2. Discharge and recover refrigerant from the system.
3. Drive belt. Refer to SECTION 6B1.
4. Refrigerant hose assembly from compressor. Refer to "Compressor and Condenser Hose Assembly."
 - Cap or plug all open connections.
5. Electrical connectors, as necessary.
6. Nuts (4) and bolts (3).
7. Compressor (1) from bracket (2).
 - Drain and measure compressor oil.



Install or Connect (Figure 21)

1. Compressor (1) to bracket (2). Refer to "Refrigerant Oil Distribution," if replacing compressor.

NOTICE: Refer to "Notice" on page 1B-1.

2. Bolts (4) and nuts (3).



Tighten

- Bolts (4) to 33 N.m (24 lbs. ft.).
3. Electrical connectors, as necessary.
 4. Refrigerant hose assembly to compressor. Refer to "Compressor and Condenser Hose Assembly."
 5. Drive belt. Refer to SECTION 6B1.
 6. Negative battery cable.
 7. Refrigerant to the system.
 - Check the system for leaks.

7.4L ENGINES



Remove or Disconnect (Figure 22)

1. Negative battery cable. Refer to SECTION 0A.
2. Discharge and recover refrigerant from the system.
3. Drive belt. Refer to SECTION 6B1.

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4. Refrigerant hose assembly from compressor. Refer to "Compressor and Condenser Hose Assembly."

- Cap or plug all open connections.

5. Electrical connectors, as necessary.
6. Bolts (5).
7. Bolt (12).
8. Bolt (15).
9. Bolt (13).
10. Braces (11 and 14).
11. Compressor (1).

- Drain and measure compressor oil.

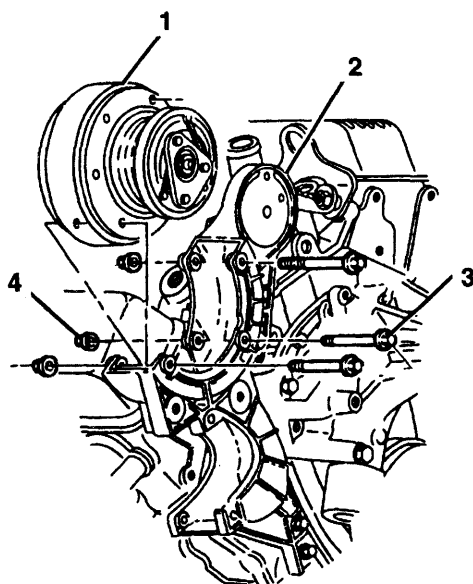
Install or Connect (Figure 22)

NOTICE: For steps 3, 4, 5, and 6, refer to "Notice" on page 1B-1.

1. Compressor (1). Refer to "Refrigerant Oil Distribution," if replacing compressor.
2. Braces (11 and 14).
3. Bolt (13).
4. Bolt (15).
5. Bolt (12).
6. Bolts (5).

Tighten

- Bolts (5) to 50 N.m (37 lbs. ft.).
- Bolts (12 and 15) to 84 N.m (62 lbs. ft.).
- Bolt (13) to 65 N.m (48 lbs. ft.).



1. COMPRESSOR, A/C
2. BRACKET, DRIVE BELT TENSIONER
3. BOLT, COMPRESSOR MOUNTING
4. NUT, COMPRESSOR MOUNTING

V3377

Figure 21—Compressor Mounting (4.3L, 5.0L, and 5.7L Engines)

7. Electrical connectors, as necessary.
8. Refrigerant hose assembly to compressor. Refer to "Compressor and Condenser Hose Assembly."
9. Drive belt. Refer to SECTION 6B1.
10. Negative battery cable.
11. Refrigerant to the system.
 - Check the system for leaks.

6.5L DIESEL ENGINES

Remove or Disconnect (Figure 23)

1. Negative battery cable. Refer to SECTION 0A.
2. Discharge and recover refrigerant from the system.
3. Drive belt. Refer to SECTION 6B1.
4. Refrigerant hose assembly from compressor. Refer to "Compressor and Condenser Hose Assembly."
 - Cap or plug all open connections.
5. Electrical connectors, as necessary.
6. Nuts (23).
7. Bolt (18) and washer (17).
8. Bolt (20) and washer (19).
9. Bolt (21) and washer (22).
10. Bolt (24) and washer (25).
11. Bracket (26).
12. Compressor (1).
 - Drain and measure compressor oil.

Install or Connect (Figure 23)

NOTICE: For steps 3, 4, 5, 6, and 7, refer to "Notice" on page 1B-1.

1. Compressor (1). Refer to "Refrigerant Oil Distribution," if replacing compressor.
2. Bracket (26).
3. Washer (25) and bolt (24).
4. Washer (22) and bolt (21).
5. Washer (19) and bolt (20).
6. Washer (17) and bolt (18).
7. Nuts (23).

Tighten

- Bolts (18, 20, 21, and 24) to 40 N.m (30 lbs. ft.).
 - Nuts (23) to 23 N.m (17 lbs. ft.).
8. Electrical connectors, as necessary.
 9. Refrigerant hose assembly to compressor. Refer to "Compressor and Condenser Hose Assembly."
 10. Drive belt. Refer to SECTION 6B1.
 11. Negative battery cable.
 12. Refrigerant to the system.
 - Check the system for leaks.

COMPRESSOR SEALING WASHERS

- When installing sealing washers, keep dirt and foreign material from getting on the sealing surfaces of the washers, hose block, or compressor ports. Clean all sealing surfaces with a lint-free rag.
- Do not reuse sealing washer.

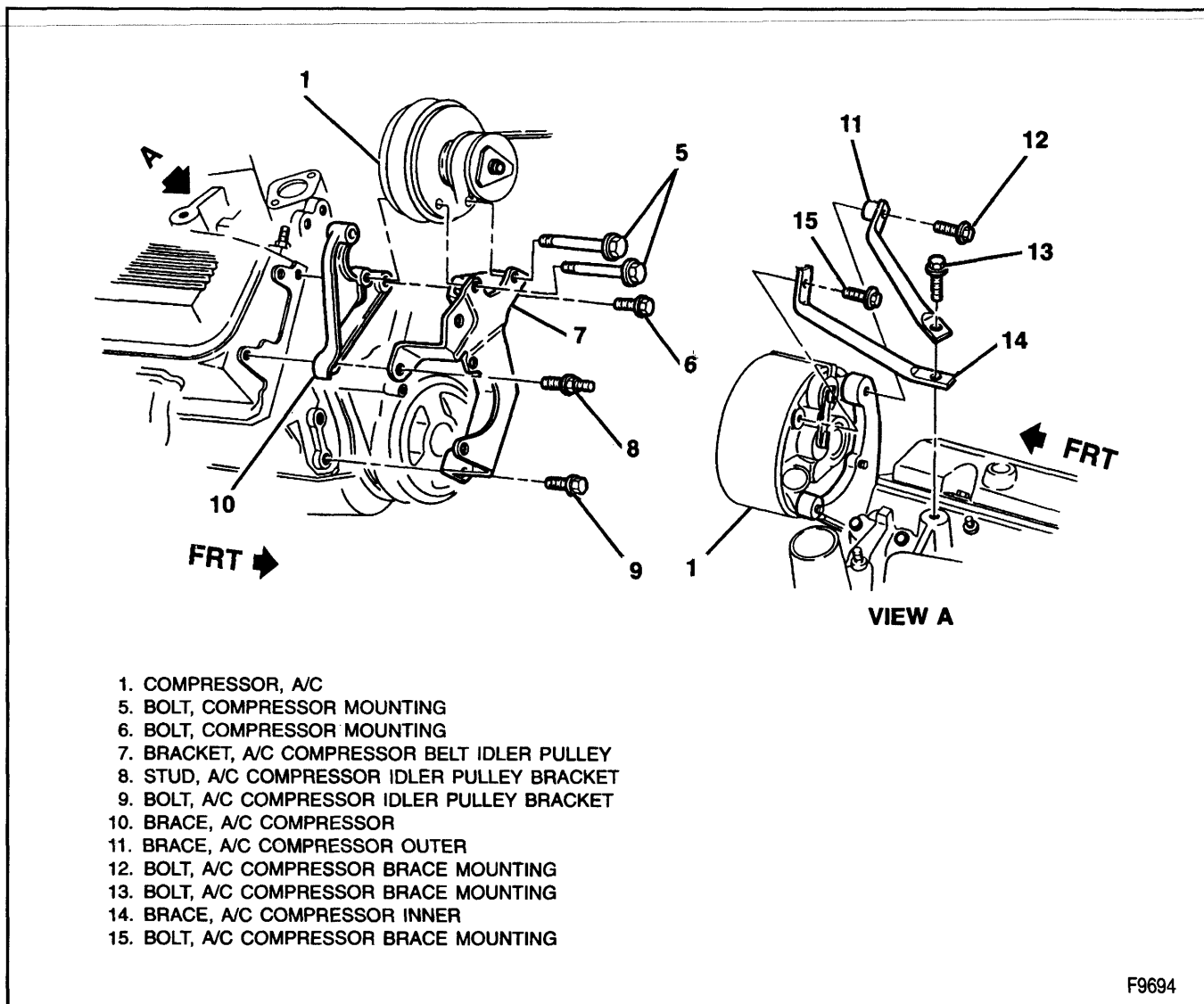


Figure 22—Compressor Mounting (7.4L Engines)

• Sealing washers do not have to be oiled prior to assembly.

1. Install sealing washer onto pilots of suction/discharge block fitting. Washers must “bottom” against surface of block fitting (figure 24).
2. Install hose block to the compressor making sure the sealing washers are seated within the compressor machined surfaces (figure 25).

NOTICE: Refer to “Notice” on page 1B-1.

3. Hold block in place, hand tighten attachment bolt (30).



Tighten

- Bolt (30) to 34 N·m (25 lbs. ft.).



Important

- If correct washers are used, there should be a 1.2-mm (0.047-inch) space between the suction/discharge hose block and the compressor rear head.

COMPRESSOR AND CONDENSER HOSE ASSEMBLY

Refer to the following figures for the models listed below:

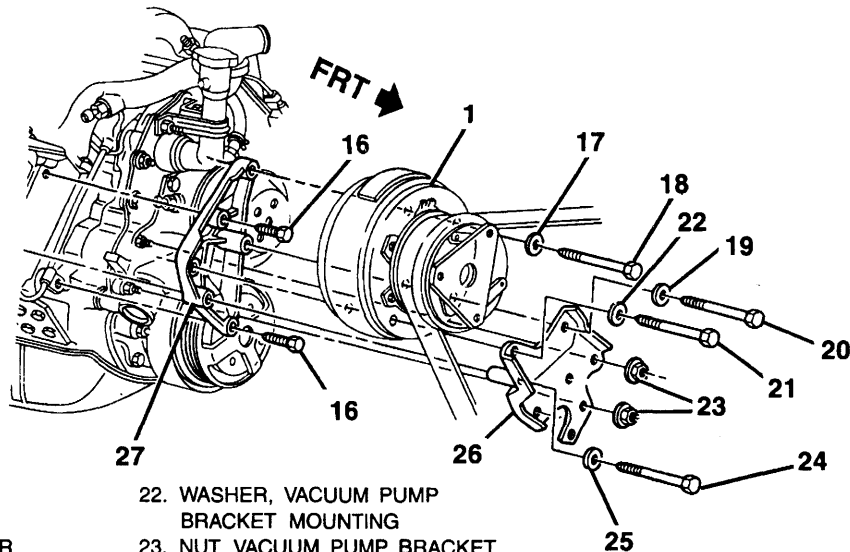
- Pickup/Extended Cab Models (4.3L, 5.0L, 5.7L, and 7.4L Engines): refer to figure 26.
- All Models (6.5L Diesel Engines): refer to figure 26.
- Suburban/Crew Cab Models (7.4L Engines w/o Aux. Heater or A/C): refer to figure 26.
- Suburban/Utility and Crew Cab Models (5.7L Engines w/o Aux. A/C): refer to figure 27.
- Suburban Models (7.4L Engines and Aux. Heater): refer to figure 28.



Remove or Disconnect (Figures 26, 27, and 28)

1. Negative battery cable. Refer to SECTION 0A.
2. Discharge and recover refrigerant from the system.

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- | | |
|---|--|
| 1. COMPRESSOR, A/C | 22. WASHER, VACUUM PUMP BRACKET MOUNTING |
| 16. BOLT, A/C COMPRESSOR SUPPORT MOUNTING | 23. NUT, VACUUM PUMP BRACKET MOUNTING |
| 17. WASHER, A/C COMPRESSOR MOUNTING | 24. BOLT, VACUUM PUMP BRACKET MOUNTING |
| 18. BOLT, A/C COMPRESSOR MOUNTING | 25. WASHER, VACUUM PUMP BRACKET MOUNTING |
| 19. WASHER, VACUUM PUMP BRACKET MOUNTING | 26. BRACKET, A/C COMPRESSOR FRONT |
| 20. BOLT, VACUUM PUMP BRACKET MOUNTING | 27. SUPPORT, A/C COMPRESSOR |
| 21. BOLT, VACUUM PUMP BRACKET MOUNTING | |

F9695

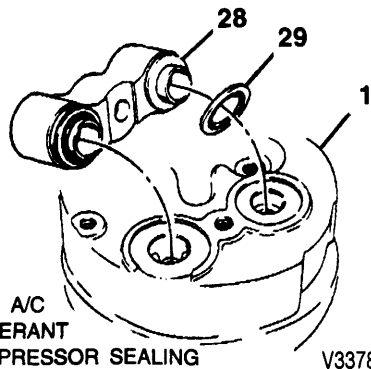
Figure 23—Compressor Mounting (6.5L Diesel Engines)

3. Grille. Refer to SECTION 2B.
4. Bolt (30).
5. Hose assembly (28) from rear of the compressor (1).
6. Sealing washers. Refer to "Compressor Sealing Washers."
7. Hose assembly (28) from accumulator (31).
8. O-ring seal (33).
9. Hose assembly (28) from condenser (32).
10. O-ring seal (34).

• Cap or plug all open connections.

 **Install or Connect (Figures 26, 27, and 28)**

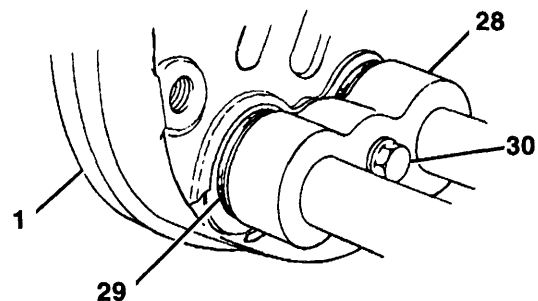
NOTICE: For steps 2, 4, and 7, refer to "Notice" on page 1B-1.



1. COMPRESSOR, A/C
28. HOSE, REFRIGERANT
29. WASHER, COMPRESSOR SEALING

V3378

Figure 24—Sealing Washer Installation (1 of 2)



1. COMPRESSOR, A/C
28. HOSE, REFRIGERANT
29. WASHER, COMPRESSOR SEALING
30. BOLT, REFRIGERANT HOSE

V3379

Figure 25—Sealing Washer Installation (2 of 2)

1. New O-ring seal (34).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
2. Hose assembly (28) to condenser (32).

 **Tighten**

- Hose assembly (28) to 24 N.m (18 lbs. ft.).
3. New O-ring seal (33).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 4. Hose assembly (28) to accumulator (31).

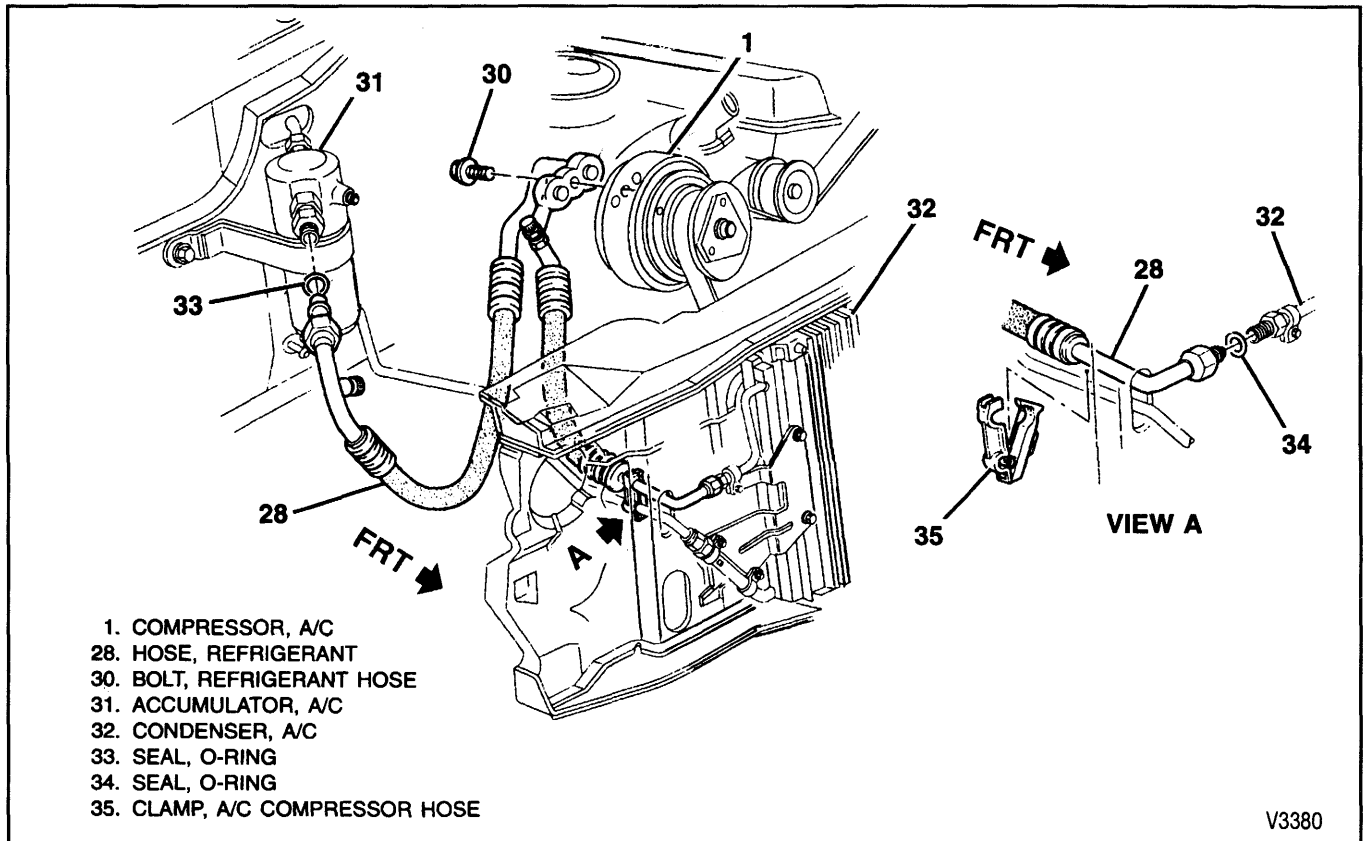


Figure 26—Compressor and Condenser Hose Assembly

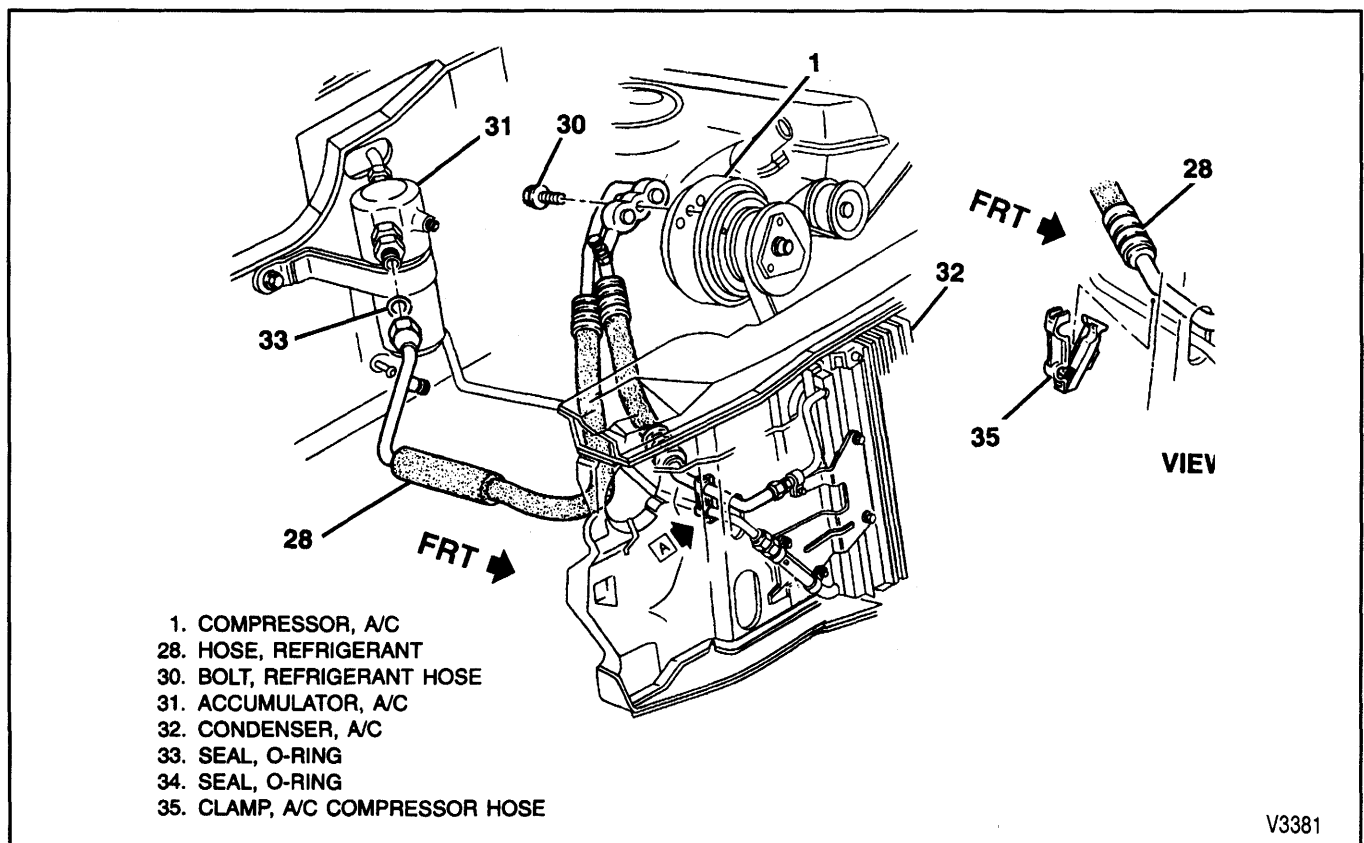


Figure 27—Compressor and Condenser Hose Assembly

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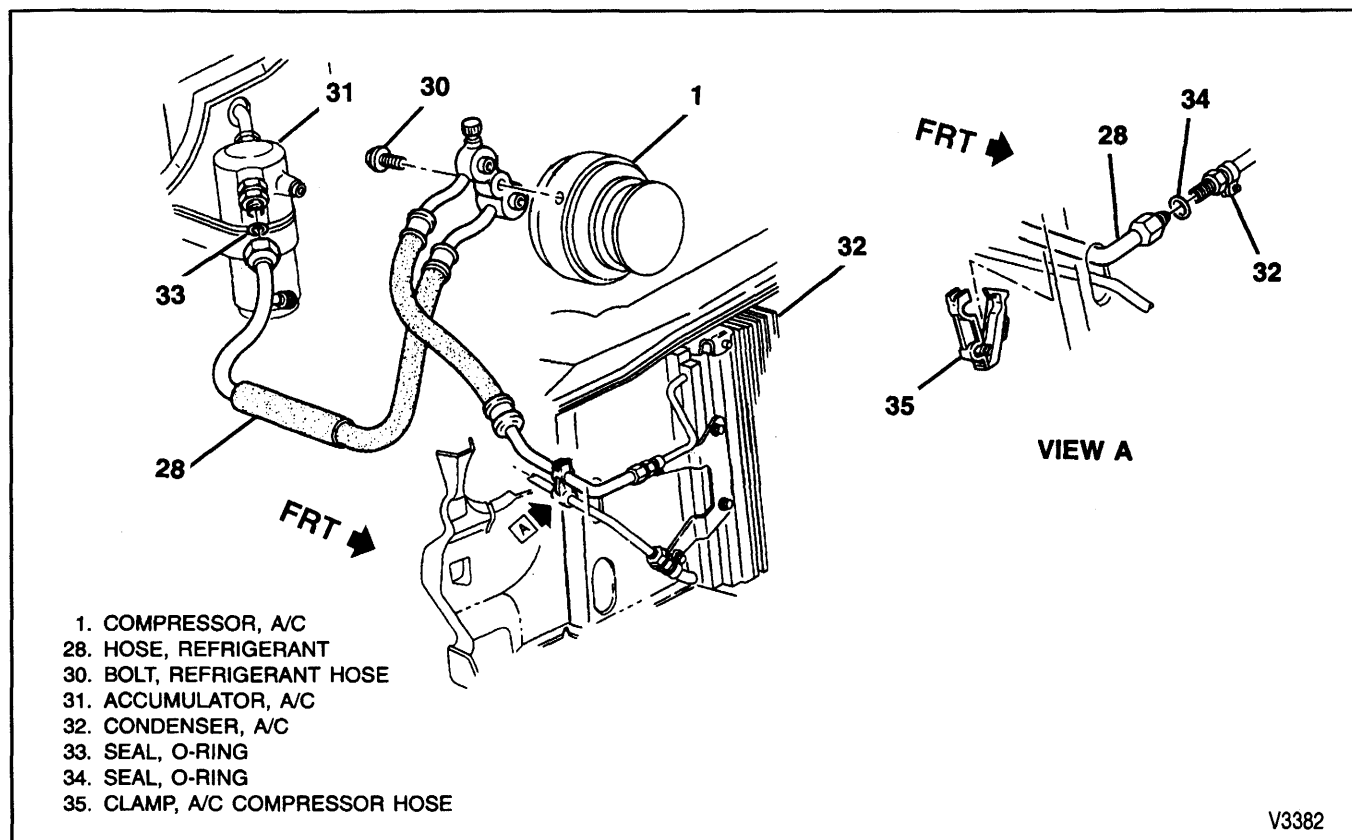


Figure 28—Compressor and Condenser Hose Assembly



Tighten

- Hose assembly (28) to 41 N.m (30 lbs. ft.).
5. Sealing washers. Refer to "Compressor Sealing Washers."
 6. Hose assembly (28) to the rear of the compressor (1).

NOTICE: Refer to "Notice" on page 1B-1.

7. Bolt (30).



Tighten

- Bolt (30) to 34 N.m (25 lbs. ft.).
8. Grille. Refer to SECTION 2B.
 9. Negative battery cable.
 10. Refrigerant to the system.
- Check the system for leaks.

COMPRESSOR PRESSURE SWITCH



Remove or Disconnect (Figure 29)

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connectors, as necessary.
3. Compressor pressure switch.
4. O-ring seal.



Install or Connect (Figure 29)

1. New O-ring seal.
 - Coat O-ring seal with 525 viscosity refrigerant oil.
2. Compressor pressure switch.



Tighten

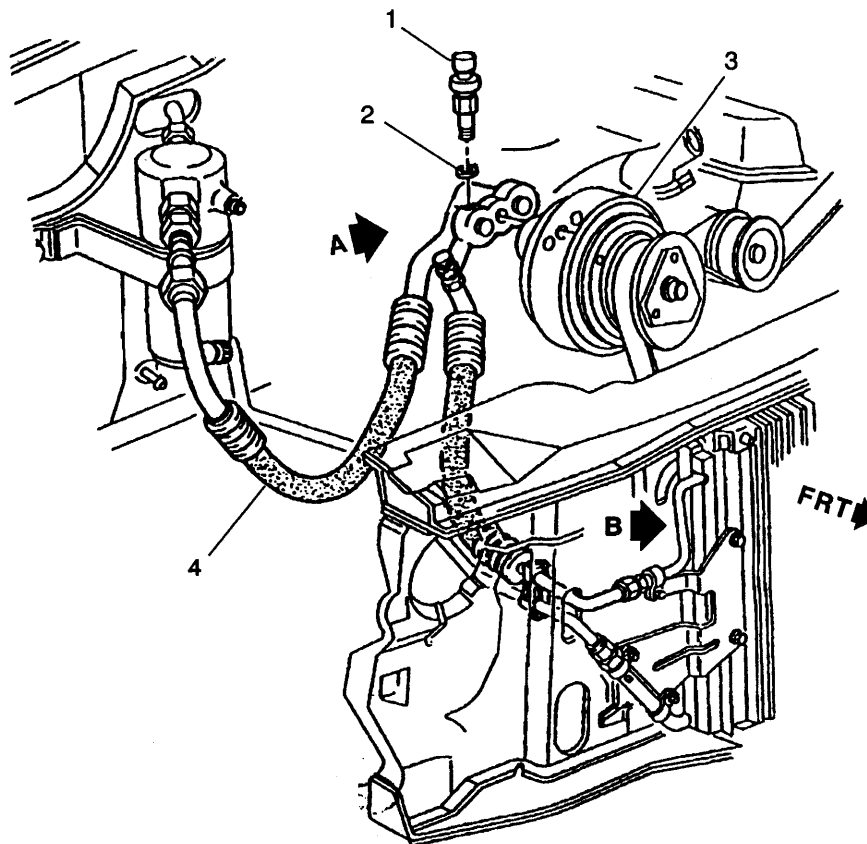
- Compressor pressure switch to 6 N.m (53 lbs. in.).
3. Electrical connectors, as necessary.
 4. Negative battery cable.

EVAPORATOR TUBE

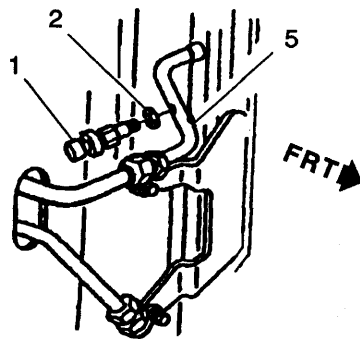


Remove or Disconnect (Figure 30)

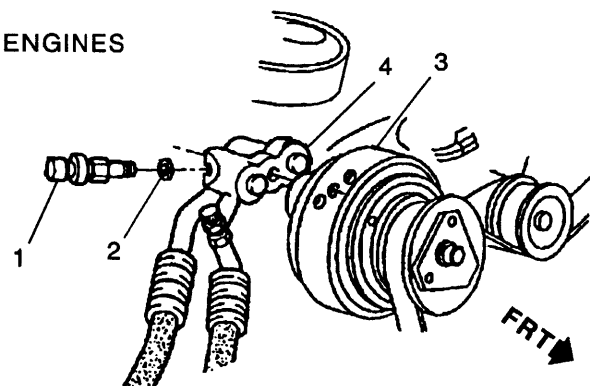
1. Negative battery cable. Refer to SECTION 0A.
2. Discharge and recover refrigerant from the system.
3. Auxiliary heater pipe, if equipped. Refer to SECTION 1A.
4. Coolant recovery reservoir. Refer to SECTION 6B1.
5. Evaporator tube (41) from evaporator (39).
6. O-ring seal (40).
7. Evaporator tube (41) from condenser (32).
8. O-ring seal (42).
9. Evaporator tube (41) from clip (43).



5.0L, 5.7L ENGINES



VIEW B



VIEW A

- A. 4.3L ENGINES
- B. 7.4L, 6.5L ENGINES
- 1. SWITCH, A/C COMPRESSOR PRESSURE
- 2. SEAL, O - RING
- 3. COMPRESSOR, A/C
- 4. HOSE ASSEMBLY, COMPRESSOR AND CONDENSER
- 5. CONDENSER, A/C

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Figure 29—Compressor Pressure Switch

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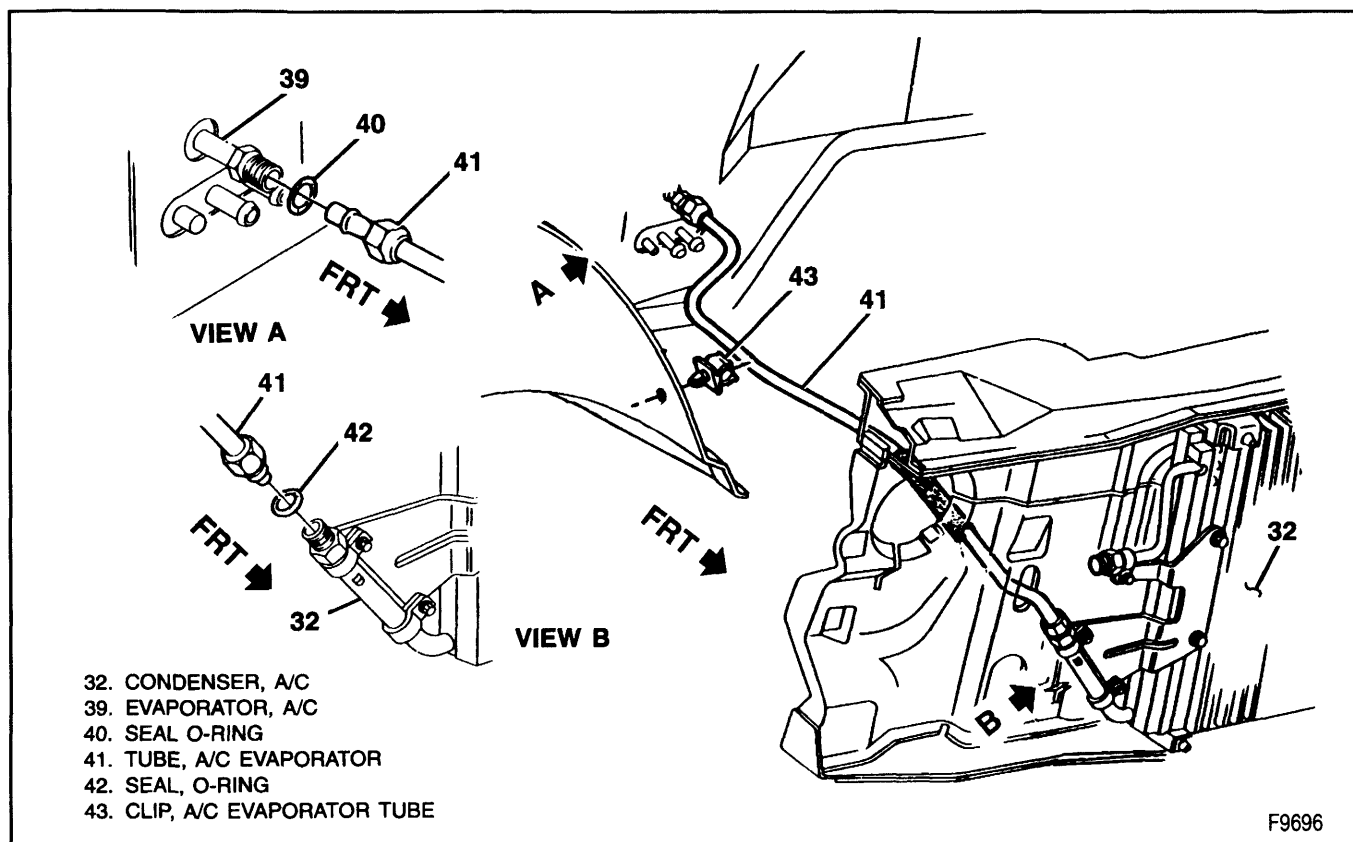


Figure 30—Evaporator Tube

Install or Connect (Figure 30)

NOTICE: For steps 3 and 5, refer to “Notice” on page 1B-1.

1. Evaporator tube (41) into clip (43).
2. New O-ring seal (42).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
3. Evaporator tube (41) to condenser (32).

Tighten

- Evaporator tube (41) to 24 N.m (18 lbs. ft.).
4. New O-ring seal (40).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 5. Evaporator tube (41) to evaporator (39).

Tighten

- Evaporator tube (41) to 24 N.m (18 lbs. ft.).
6. Coolant recovery reservoir. Refer to SECTION 6B1.
 7. Auxiliary heater pipe, if equipped. Refer to SECTION 1A.
 8. Negative battery cable.
 9. Refrigerant to the system.
 - Check the system for leaks.

BLOWER MOTOR RELAY

Remove or Disconnect (Figure 31)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Relay (76) from relay bracket.

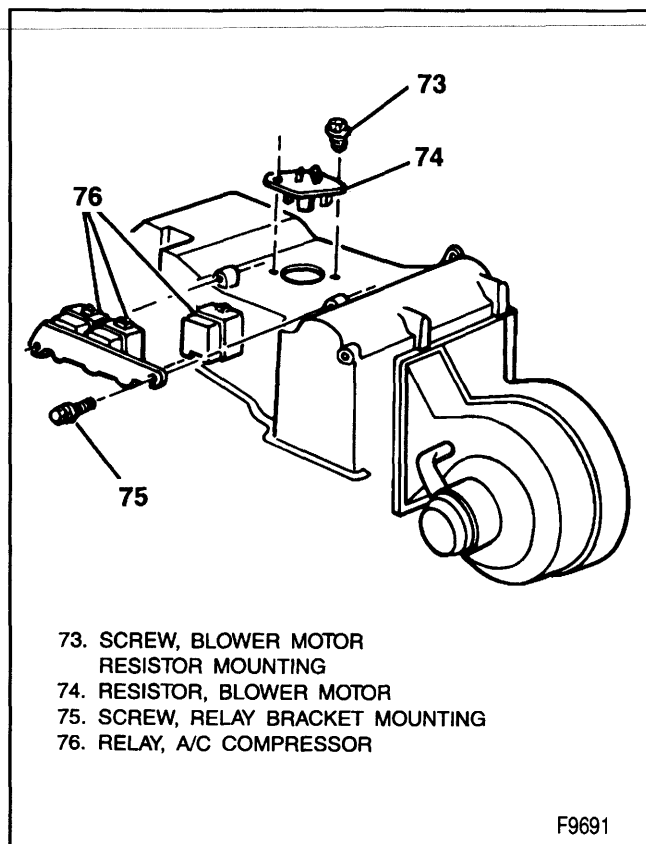
Install or Connect (Figure 31)

1. Relay (76) to relay bracket.
2. Electrical connectors, as necessary.
3. Instrument panel compartment. Refer to SECTION 10A4.
4. Negative battery cable.
 - Check circuit operation.

CONDENSER

Remove or Disconnect (Figure 32)

1. Discharge and recover refrigerant from the system.
2. Grille. Refer to SECTION 2B.
3. Hood primary latch support.
4. Auxiliary cooling fan, if equipped. Refer to SECTION 6B1.
5. Refrigerant hose from condenser. Refer to “Compressor and Condenser Hose Assembly.”



- 73. SCREW, BLOWER MOTOR RESISTOR MOUNTING
- 74. RESISTOR, BLOWER MOTOR
- 75. SCREW, RELAY BRACKET MOUNTING
- 76. RELAY, A/C COMPRESSOR

F9691

Figure 31—Blower Motor Relay/Resistor

6. Evaporator tube from condenser. Refer to "Evaporator Tube."
 - Cap or plug all open connections.
7. Bolts (46).
8. Brackets (45).
9. Upper insulators (44).
10. Condenser (32).
 - Bend the left grille support outboard to gain clearance for the condenser removal.
11. Lower insulators (47).

Install or Connect (Figure 32)

1. Lower insulators (47).
2. Condenser (32). Refer to "Refrigerant Oil Distribution," if replacing condenser.
3. Upper insulators (44).
4. Brackets (45).

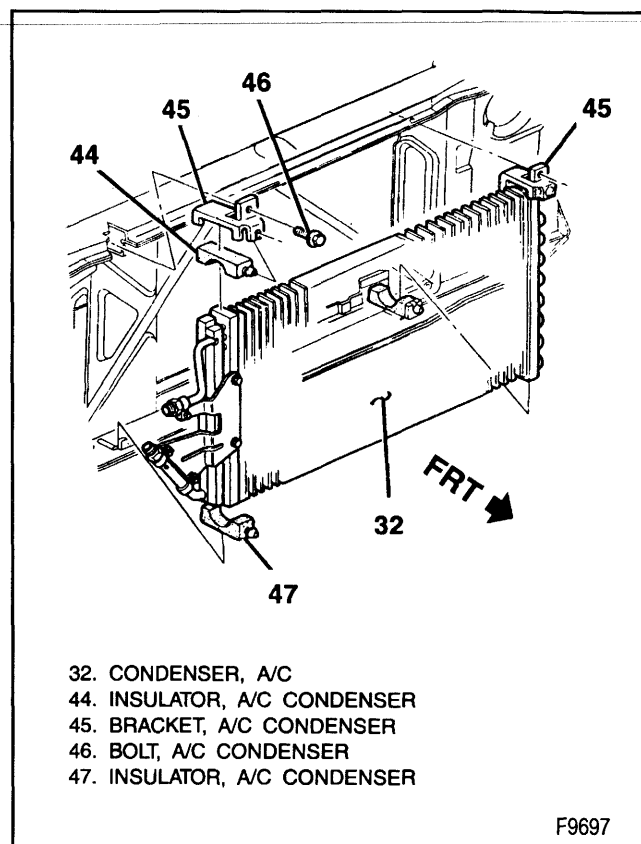
NOTICE: Refer to "Notice" on page 1B-1.

5. Bolts (46).



Tighten

- Bolts (46) to 4.5 N.m (40 lbs. in.).
- 6. Evaporator tube to condenser. Refer to "Evaporator Tube."
- 7. Refrigerant hose to condenser. Refer to "Compressor and Condenser Hose Assembly."
- 8. Auxiliary cooling fan, if equipped. Refer to SECTION 6B1.



- 32. CONDENSER, A/C
- 44. INSULATOR, A/C CONDENSER
- 45. BRACKET, A/C CONDENSER
- 46. BOLT, A/C CONDENSER
- 47. INSULATOR, A/C CONDENSER

F9697

Figure 32—Condenser Assembly

9. Hood primary latch support.
10. Grille assembly. Refer to SECTION 2B.
11. Refrigerant to the system.
 - Check the system for leaks.

ACCUMULATOR

Remove or Disconnect (Figure 33)

1. Negative battery cable. Refer to SECTION 0A.
2. Discharge and recover refrigerant from the system.
3. Electrical connectors, as necessary.
4. Pressure cycling switch.
5. Refrigerant hose from accumulator. Refer to "Compressor and Condenser Hose Assembly."
6. Accumulator from the evaporator.
7. O-ring seal.



Important

- Cap or plug all open connections.
- 8. Accumulator bracket screw.
- 9. Accumulator.
- 10. Upper and lower accumulator insulators.

Install or Connect (Figure 33)

1. Upper and lower accumulator insulators.
2. Accumulator (31). Refer to "Refrigerant Oil Distribution," if replacing accumulator.

NOTICE: Refer to "Notice" on page 1B-1.

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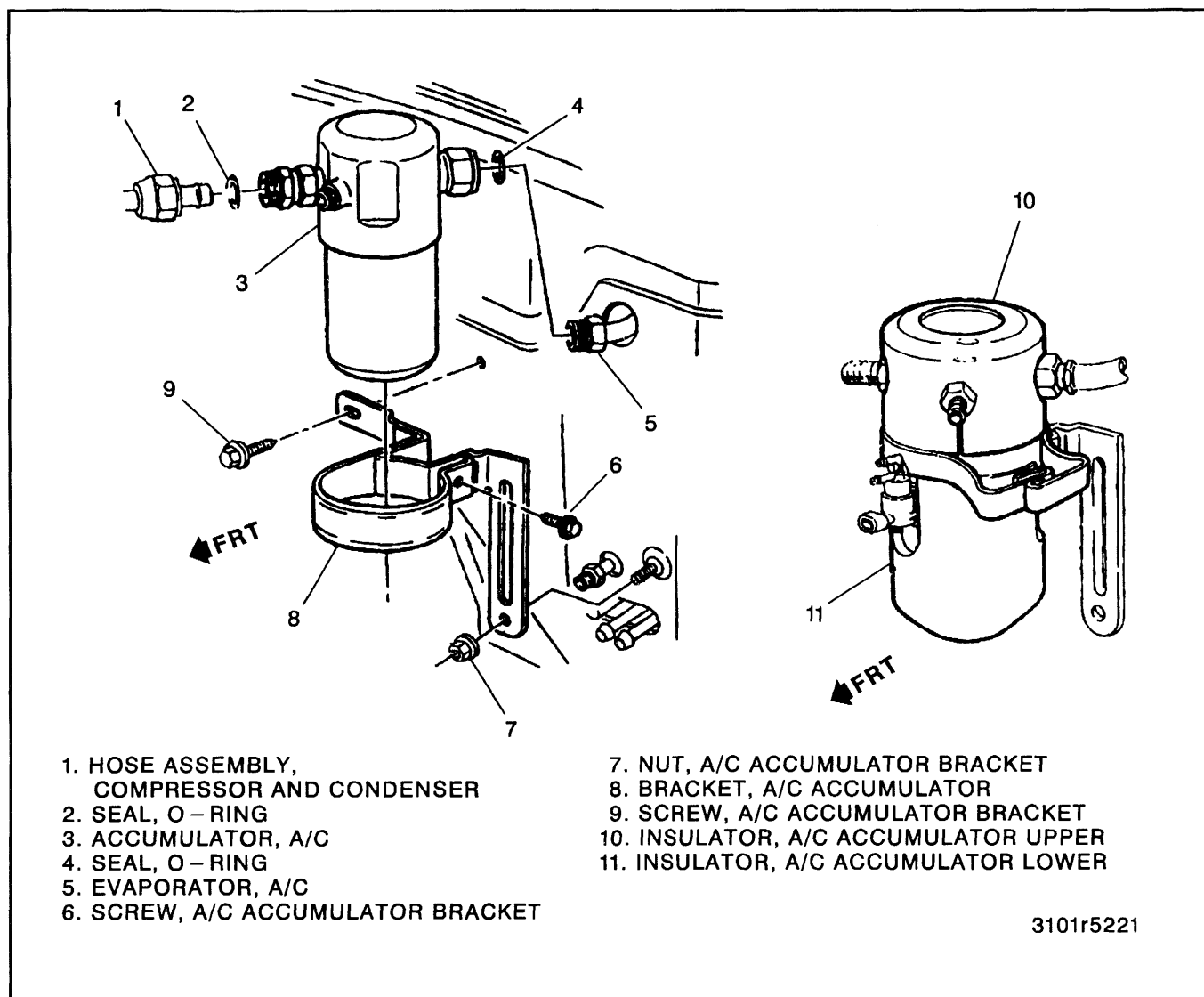


Figure 33—Accumulator

3. Accumulator bracket screw.



Tighten

- Screw to 6 N.m (53 lbs. in.).

4. New O-ring seal.

- Coat O-ring seal with 525 viscosity refrigerant oil.

5. Accumulator to the evaporator.



Tighten

- Accumulator to 41 N.m (30 lbs. ft.).

6. Refrigerant hose to accumulator. Refer to "Compressor and Condenser Hose Assembly."

7. Pressure cycling switch.

8. Electrical connectors, as necessary.

9. Negative battery cable.

10. Refrigerant to the system.

- Check the system for leaks.

EXPANSION (ORIFICE) TUBE

FRONT A/C SYSTEM (C60)

Tool Required:

J 26549-E Orifice Tube Remover and Installer or Equivalent



Remove or Disconnect (Figure 30)

1. Discharge and recover refrigerant from the system.
2. Grille. Refer to SECTION 2B.
3. Evaporator tube (41) from condenser (32). Refer to "Evaporator Tube."
4. O-ring seal (42).

- Cap or plug the open line.

5. Expansion (orifice) tube from the condenser outlet pipe, using J 26549-E or equivalent.

In the event that difficulty is encountered during the removal of a restricted or plugged expansion (orifice) tube, the following procedure is recommended:

- A. Remove as much of any impacted residue as possible.
- B. Carefully apply heat with heat gun (hair drier, epoxy drier or equivalent) approximately 7 mm (1/4 inch) from dimples on inlet pipe. Do not overheat pipe.

NOTICE: If the system has a pressure switch near the expansion tube location, it should be removed prior to heating the pipe to avoid damage to switch.

- C. While applying heat, use expansion tube removal tools J 26549-E or equivalent to grip the expansion (orifice) tube. Use a turning motion along with a push-pull motion to loosen the impacted expansion(orifice) tube and remove it.

Install or Connect (Figure 30)

1. Expansion tube into condenser outlet pipe, using J 26549-E or equivalent.
2. New O-ring seal (42).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 - Insert the short screen end of the new orifice into the evaporator tube.
3. Evaporator tube (41) to condenser (32). Refer to "Evaporator Tube."
4. Grille. Refer to SECTION 2B.
5. Refrigerant to the system.
 - Check the system for leaks.

EVAPORATOR CORE

Remove or Disconnect (Figure 34)

1. Negative battery cable. Refer to SECTION 0A.
2. Engine coolant. Refer to SECTION 6B1.
3. Discharge and recover refrigerant from the system.
4. Instrument panel compartment. Refer to SECTION 10A4.
5. Electrical connectors, as necessary.
6. Center floor air distribution duct.
7. ECM and mounting tray.
8. Hinge pillar trim panels. Refer to SECTION 10A4.
9. Blower motor cover.
10. Blower motor (60). Refer to "Blower Motor and Fan."
11. Steering wheel. Refer to SECTION 3F.
12. Tilt back instrument panel assembly. Refer to SECTION 10A4.
13. Coolant recovery reservoir. Refer to SECTION 6B1.
14. Heater hoses. Refer to SECTION 1A.
15. Evaporator tube. Refer to "Evaporator Tube."
16. Accumulator. Refer to "Accumulator."
17. Screws (52 and 64).
18. Nut (50).
19. Screw (56).
20. Module assembly (57).
 - May be necessary to have an assistant when removing module assembly.
21. Evaporator case bottom cover plate (63).
 - Remove the seven screws that hold the cover plate to the module assembly.

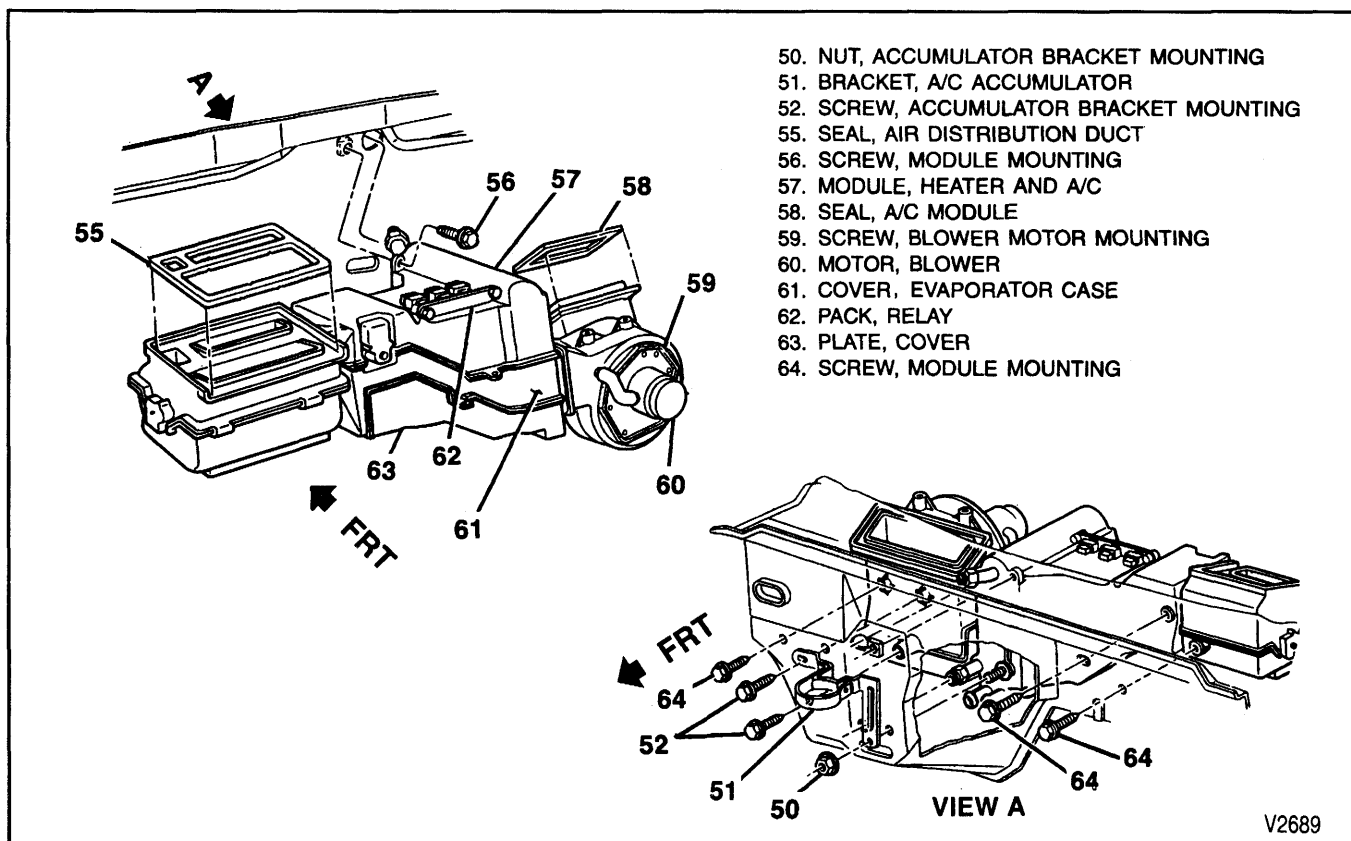


Figure 34—Evaporator/Heater Core Case

V2689

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22. Heater core and seal from module assembly.
23. Evaporator case cover (61).
 - Remove the four screws that hold the case cover to the module assembly.
24. Evaporator core.

Install or Connect (Figure 34)

1. Evaporator core. Refer to "Refrigerant Oil Distribution," if replacing evaporator core.

NOTICE: For steps 2, 4, 6, 7, and 8, refer to "Notice" on page 1B-1.

2. Evaporator case cover (61).
 - Install the four screws that hold the case cover to the module assembly.
3. Heater core and seal into module assembly.
4. Evaporator case bottom cover plate (63).
 - Install the seven screws that hold the cover plate to the module assembly.
5. Module assembly (57).
 - May be necessary to have an assistant when installing module assembly.
6. Screw (56).
7. Nut (50).
8. Screws (52 and 64).

Tighten

- Screw (56) to 11 N.m (97 lbs. in.).
 - Nut (50) to 2.8 N.m (25 lbs. in.).
 - Screws (52 and 64) to 1.9 N.m (17 lbs. in.).
9. Accumulator. Refer to "Accumulator."
 10. Evaporator tube. Refer to "Evaporator Tube."
 11. Heater hoses. Refer to SECTION 1A.
 12. Coolant recovery reservoir. Refer to SECTION 6B1.
 13. Instrument panel. Refer to SECTION 10A4.
 14. Steering wheel. Refer to SECTION 3F.
 15. Blower motor (60). Refer to "Blower Motor and Fan."
 16. Blower motor cover.
 17. Hinge pillar trim panels. Refer to SECTION 10A4.
 18. ECM and mounting tray.
 19. Center floor air distribution duct.
 20. Electrical connectors, as necessary.
 21. Instrument panel compartment. Refer to SECTION 10A4.
 22. Engine coolant. Refer to SECTION 6B1.
 23. Negative battery cable.
 24. Refrigerant to the system.
 - Check the system for leaks.

BLOWER MOTOR AND FAN

Remove or Disconnect (Figure 34)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.
3. Front screw from right door sill plate.
4. Right hinge pillar trim panel. Refer to SECTION 10A4.
5. Electrical connectors from ECM, as necessary.
6. ECM and mounting bracket.

7. Electrical connectors from blower motor (60), as necessary.
8. Courtesy lamp (if equipped).
9. Bolt from right lower dash support.
10. Blower motor cover.
11. Blower motor cooling tube.
12. Blower motor flange screws (59).
13. Blower motor (60).

- Pull the blower motor forward carefully to avoid distorting the blower fan.
- May be necessary to pry back right side of instrument panel.

Inspect

- Blower motor terminals for distortion. Clean corrosion from the terminals or replace the blower motor (60) as necessary.
- Flange of the blower motor (60) for damage or distortion that could cause an air leak. Repair as necessary.
- Blower fan for damage and distortion.

Install or Connect (Figure 34)

1. Blower motor (60).
 - Guide the blower motor and blower fan into position, being careful not to catch the blower fan on protruding parts.
2. Blower motor flange screws (59).
3. Blower motor cooling tube.
4. Blower motor cover.
5. Bolt to right lower dash support.
6. Courtesy lamp (if equipped).
7. Electrical connectors to blower motor (16), as necessary.
8. Mounting bracket and ECM.
9. Electrical connectors to ECM, as necessary.
10. Right hinge pillar trim panel. Refer to SECTION 10A4.
11. Front screw into front door sill plate.
12. Instrument panel compartment. Refer to SECTION 10A4.
13. Negative battery cable.
 - Check circuit operation.

BLOWER MOTOR RESISTOR

Remove or Disconnect (Figure 31)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Screws (73).
5. Blower motor resistor (74).

Install or Connect (Figure 31)

1. Blower motor resistor (74).

NOTICE: Refer to "Notice" on page 1B-1.

2. Screws (73).

Tighten

- Screws (73) to 1.4 N.m (12 lbs. in.).

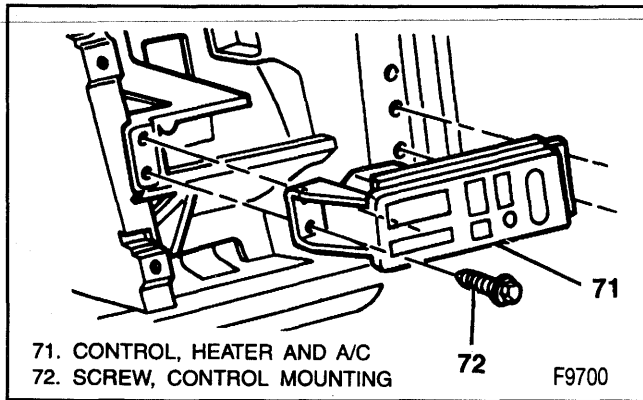


Figure 35—Control Assembly

3. Electrical connectors, as necessary.
4. Instrument panel compartment. Refer to SECTION 10A4.
5. Negative battery cable.
 - Check circuit operation.

CONTROL ASSEMBLY AND BLOWER SWITCH

Remove or Disconnect (Figure 35)

1. Instrument panel bezel. Refer to SECTION 8C.
2. Screws (72).
 - Pull the control assembly out from the instrument panel.
3. Electrical connectors, as necessary.

4. Control assembly (71).

Install or Connect (Figure 35)

1. Electrical connectors, as necessary.
2. Control assembly (71).

NOTICE: Refer to "Notice" on page 1B-1.

3. Screws (72).

Tighten

- Screws (72) to 1.9 N.m (17 lbs. in.).
- 4. Instrument panel bezel. Refer to SECTION 8C.
- Check circuit operation.

HEATER HOSES

For complete replacement procedure, refer to SECTION 1A.

HEATER CORE

For complete replacement procedure, refer to SECTION 1A.

AIR DISTRIBUTOR DUCT

Remove or Disconnect (Figure 36)

1. Negative battery cable. Refer to SECTION 0A.
2. Defroster nozzle (80). Refer to "Defroster Nozzle."

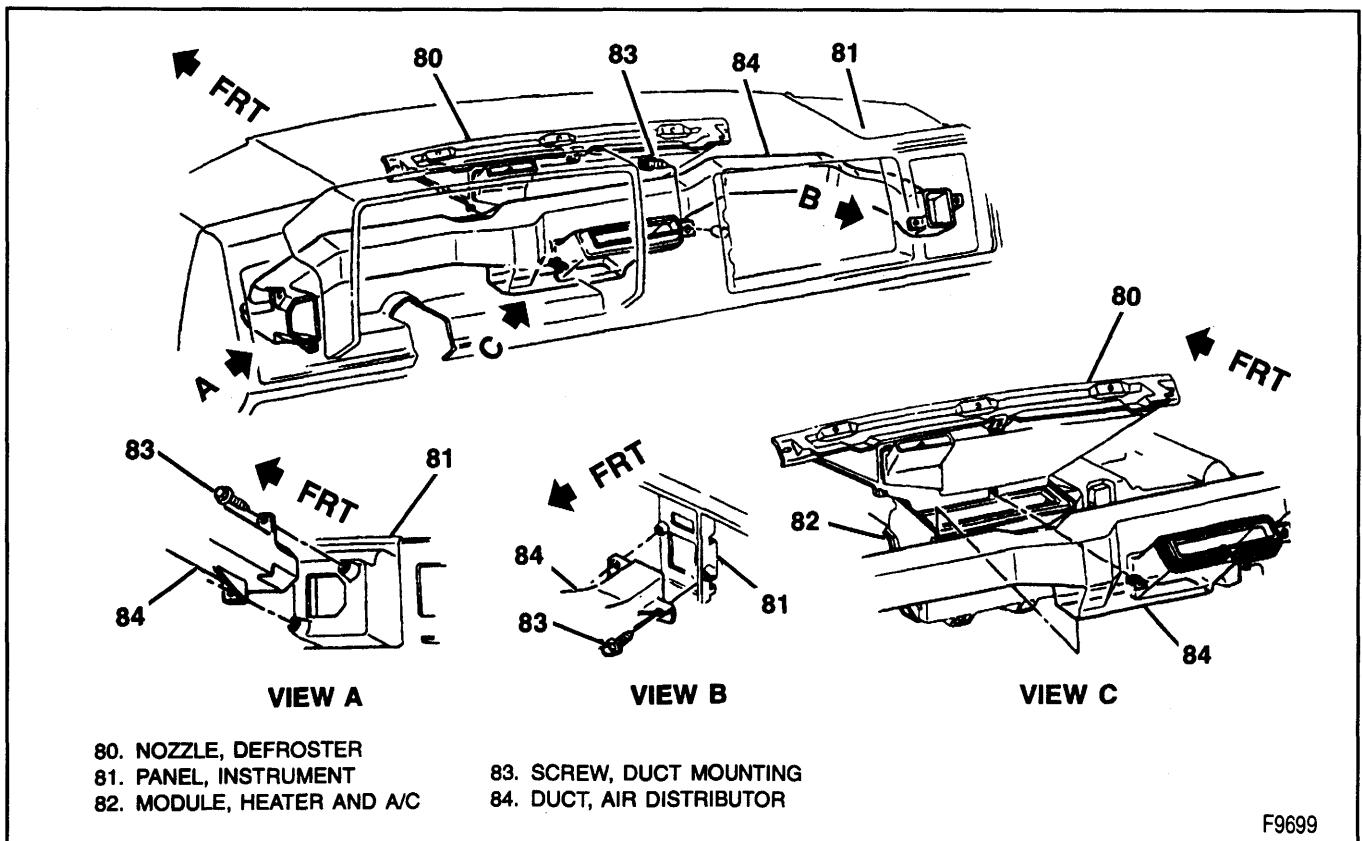


Figure 36—Air Distributor Duct

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3. Five duct mounting screws (83).

- Two from each side dash vent outlet.
- One from center dash vent outlet.

4. Duct (84) from instrument panel (81).

Install or Connect (Figure 36)

1. Duct (84) to instrument panel (81).

NOTICE: Refer to "Notice" on page 1B-1.

2. Duct mounting screws (83).



- Screws (83) to 1.9 N·m (17 lbs. in.).

3. Defroster nozzle (80). Refer to "Defroster Nozzle."
4. Negative battery cable.

DEFROSTER NOZZLE

Remove or Disconnect (Figure 37)

1. Negative battery cable. Refer to SECTION 0A.
2. Tilt back instrument panel assembly (81). Refer to SECTION 10A4.
3. Screws (77).
4. Screws (78).
5. Screws (79).
6. Defroster nozzle (80).

Install or Connect (Figure 37)

1. Defroster nozzle (80).

NOTICE: For steps 2, 3, and 4, refer to "Notice" on page 1B-1.

2. Screws (79).



- Screws (79) to 1.4 N·m (12 lbs. in.).
3. Screws (78).
4. Screws (77).



- Screws (77 and 78) to 1.9 N·m (17 lbs. in.).
5. Instrument panel. Refer to SECTION 10A4.
6. Negative battery cable.

TEMPERATURE/DEFROST ACTUATOR

The temperature/defrost actuator is located on the left side of the air distribution case.

Remove or Disconnect (Figure 38)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.

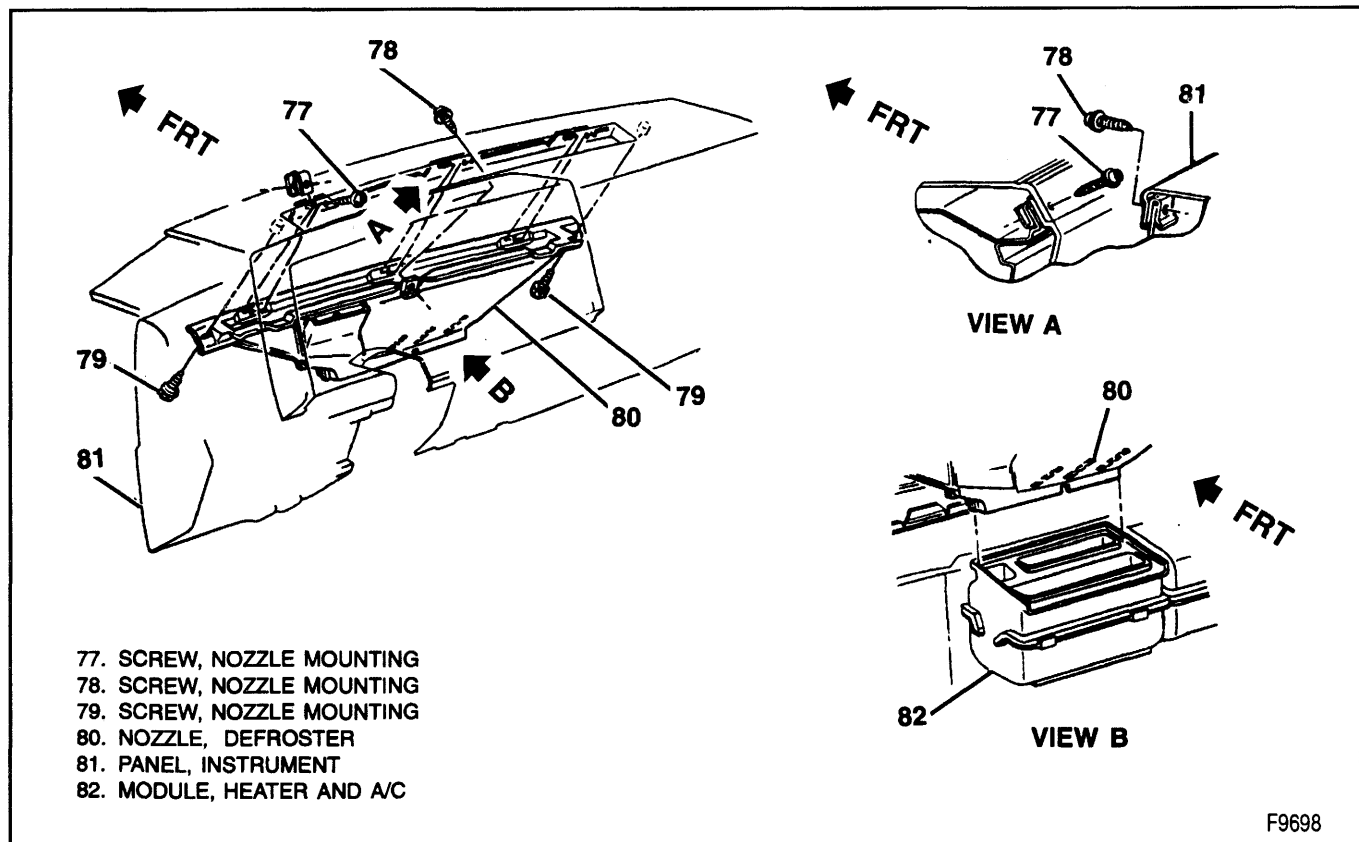


Figure 37—Defroster Nozzle

3. Electrical connectors, as necessary.
4. Adjuster links (66) from control lever (68).
5. Screws (67).
6. Temperature/defrost actuator (69).



Adjust

1. Electrical connection to the actuator.
2. Turn the ignition key to the run position and let the actuator position itself.
3. Turn off the ignition key.
4. Remove the actuator from the electrical connection.



Install or Connect (Figure 38)

1. Temperature/defrost actuator (69).
2. Screws (67).
3. Adjuster links (66) to control lever (68).
4. Electrical connectors, as necessary.
5. Instrument panel compartment. Refer to SECTION 10A4.
6. Negative battery cable.
 - Check circuit operation.

MODE ACTUATOR

The mode actuator is located on the air distributor case between the air distributor and blower assembly.



Remove or Disconnect (Figure 38)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Screws (70).
5. Mode actuator (65).



Adjust

1. Electrical connection to the actuator.
2. Turn the ignition key to the run position and let the actuator position itself.
3. Turn off the ignition key.
4. Remove the actuator from the electrical connection.



Install or Connect (Figure 38)

1. Mode actuator (65).
2. Screws (70).
3. Electrical connectors, as necessary.
4. Instrument panel compartment. Refer to SECTION 10A4.
5. Negative battery cable.
 - Check circuit operation.

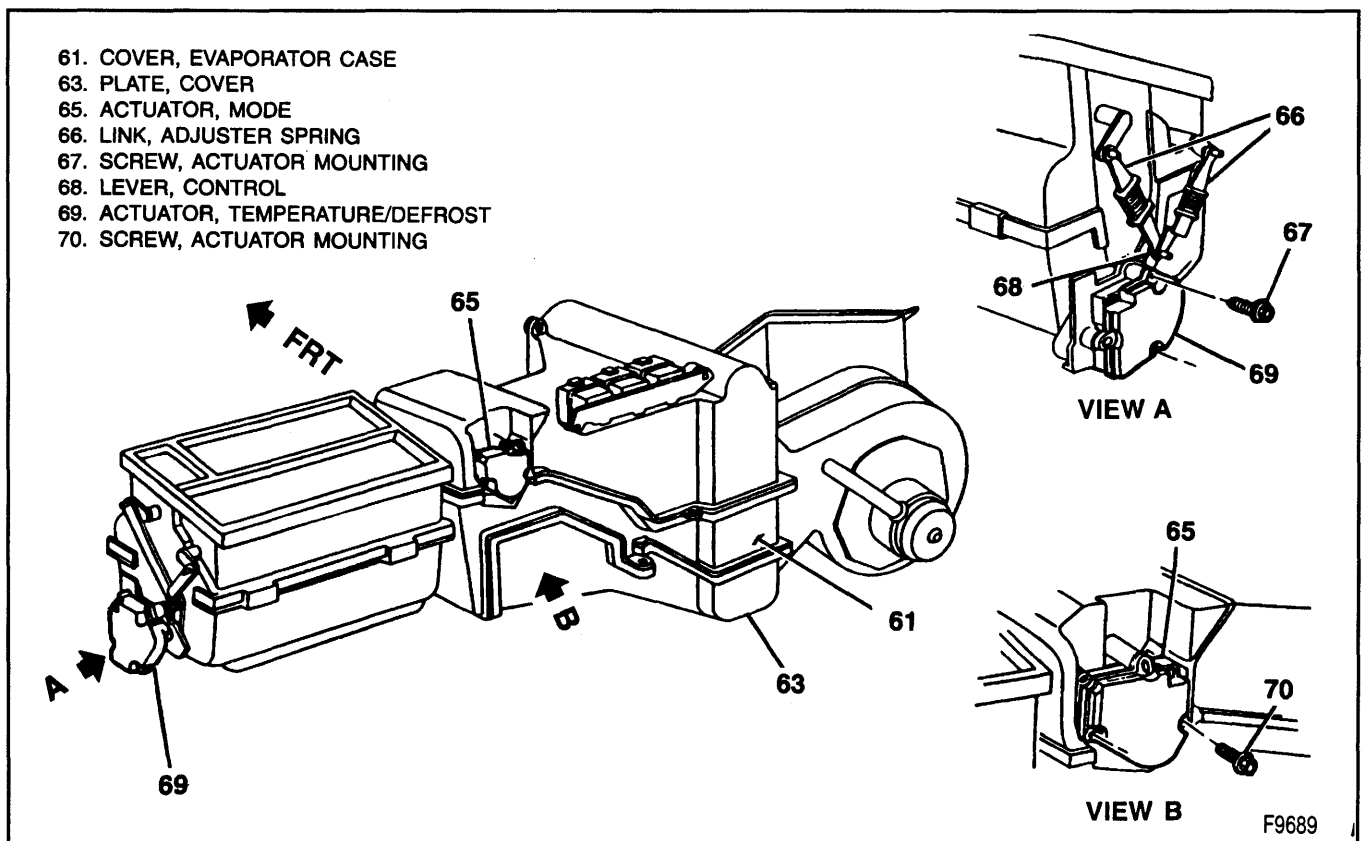


Figure 38—Temperature/Defrost and Mode Actuator

ON-VEHICLE SERVICE—REAR A/C SYSTEM (SUBURBAN)

CONTROL ASSEMBLY

FRONT OVERHEAD (AUX. HEATER AND A/C)

↔ Remove or Disconnect (Figure 39)

1. Roof console (1). Refer to SECTION 10A4.
2. Electrical harness (2) from control assembly (3).
3. Control assembly (3) from roof console (1).

↔ Install or Connect (Figure 39)

1. Control assembly (3) to roof console (1).
2. Electrical harness (2) to control assembly (3).
3. Roof console (1). Refer to SECTION 10A4.

- Check circuit operation.

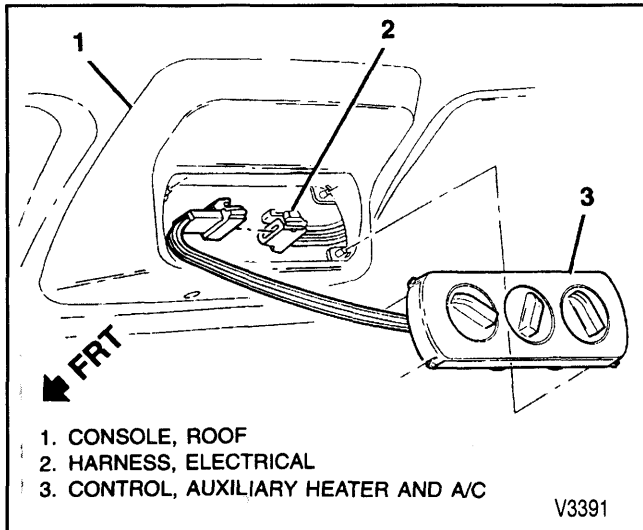


Figure 39—Front Overhead Auxiliary Control Switch

CENTER OVERHEAD (AUX. HEATER AND A/C)

↔ Remove or Disconnect (Figure 40)

1. Bezel (5).
2. Control assembly (3) from roof panel (4).
3. Electrical harness (2) from control assembly (3).

↔ Install or Connect (Figure 40)

1. Electrical harness (2) to control assembly (3).
 2. Control assembly (3) to roof panel (4).
 3. Bezel (5).
- Check circuit operation.

EVAPORATOR TUBE

↔ Remove or Disconnect (Figure 41)

1. Discharge and recover refrigerant from the system.
2. Evaporator tube (10) from evaporator (17).
3. O-ring seal (18).
4. Evaporator tube (10) from condenser (9).
5. O-ring seal (18).
6. Evaporator tube (10) from auxiliary evaporator hose (15).
7. O-ring seal.
8. Evaporator tube (10).

↔ Install or Connect (Figure 41)

NOTICE: For steps 3, 5, and 7, refer to "Notice" on page 1B-1.

1. Evaporator tube (10).
 2. New O-ring seal.
- Coat O-ring seal with 525 viscosity refrigerant oil.

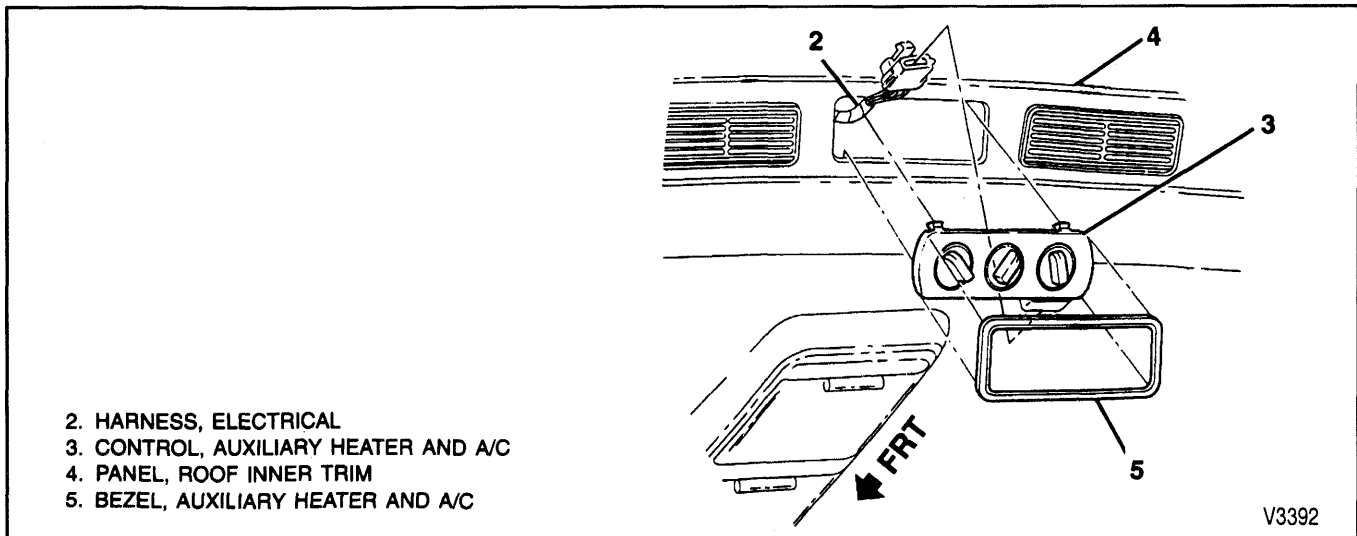


Figure 40—Center Overhead Auxiliary Control Switch

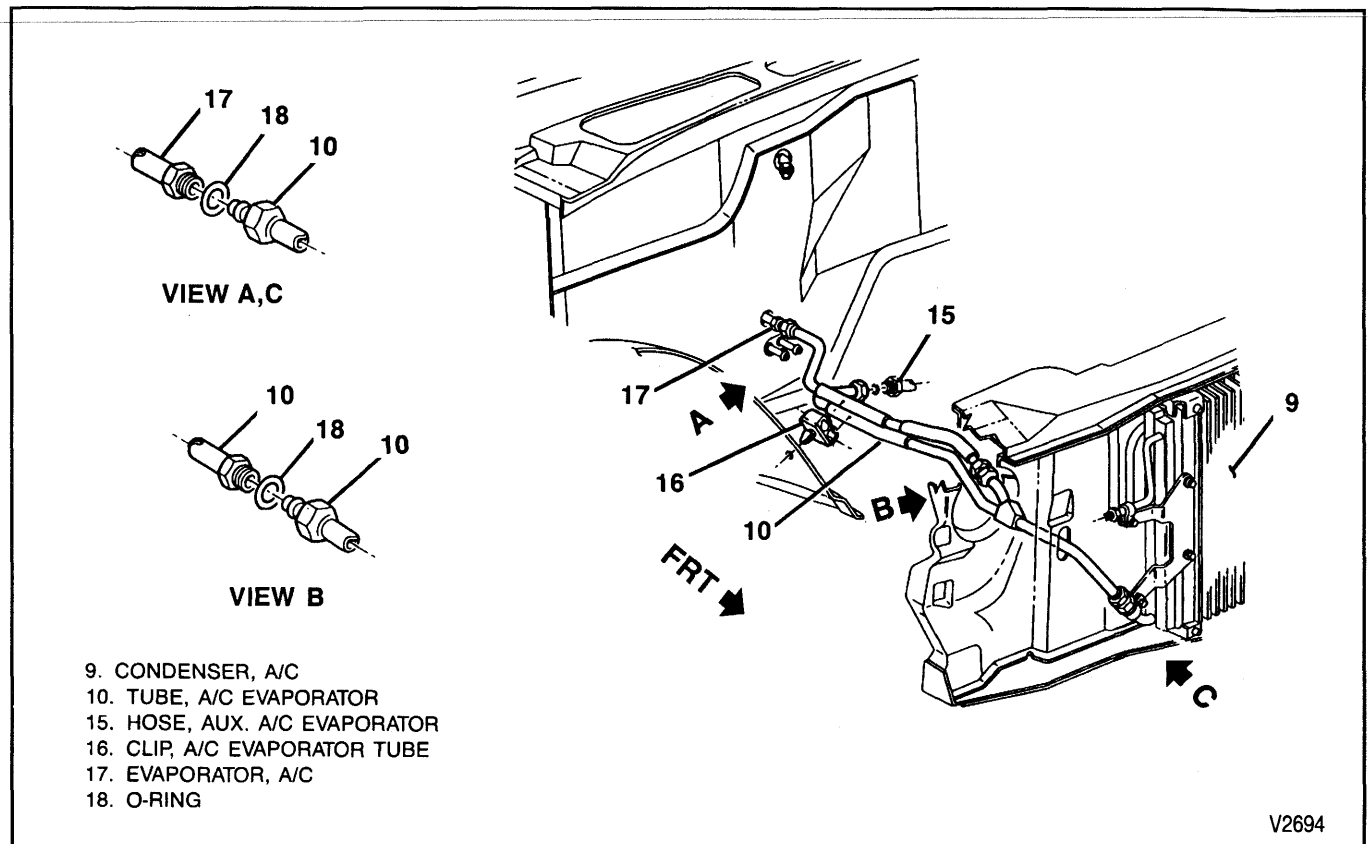


Figure 41—Auxiliary Evaporator Tube

3. Evaporator tube (10) to auxiliary evaporator hose (15).



Tighten

- Evaporator tube (10) to 24 N.m (18 lbs. ft.).
4. New O-ring seal (18).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 5. Evaporator tube (10) to condenser (9).



Tighten

- Evaporator tube (10) to 24 N.m (18 lbs. ft.).
6. New O-ring seal (18).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 7. Evaporator tube (10) to evaporator (17).



Tighten

- Evaporator tube (10) to 24 N.m (18 lbs. ft.).
8. Refrigerant to the system.
 - Check the system for leaks.

COMPRESSOR AND CONDENSER HOSE ASSEMBLY



Remove or Disconnect (Figures 42, 43, and 44)

1. Discharge and recover refrigerant from the system.
2. Auxiliary heater pipe, if equipped. Refer to SECTION 1A.

3. Compressor support braces.
4. Bolt (7).
5. Hose assembly (11) from rear of the compressor (8).
6. Sealing washers. Refer to "Compressor Sealing Washers."
7. Hose assembly (11) from accumulator (6).
8. O-ring seal (12).
9. Vacuum tank.
10. Hose assembly (11) from condenser (9).
11. O-ring seal (13).
12. Hose assembly (11) from auxiliary compressor hose (21) (figure 43).
13. O-ring seal (22).
 - Cap or plug all open connections.



Install or Connect (Figures 42, 43, and 44)

NOTICE: For steps 2, 4, 6, and 8, refer to "Notice" on page 1B-1.

1. New O-ring seal (22).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
2. Hose assembly (11) to auxiliary compressor hose (21) (figure 43).



Tighten

- Hose assembly (11) to 24 N.m (18 lbs. ft.).
3. New O-ring seal (13).
 - Coat O-ring seal with 525 viscosity refrigerant oil.

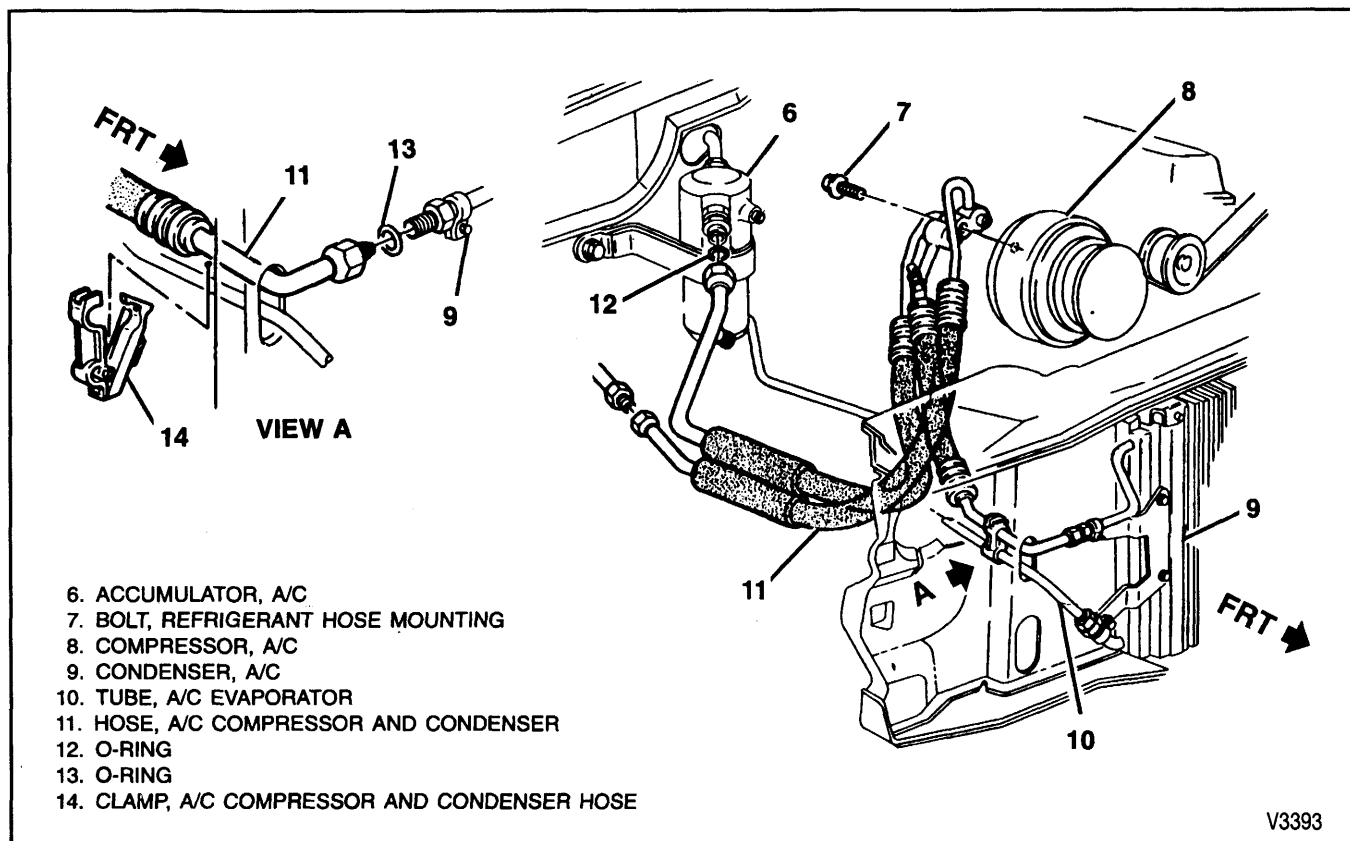


Figure 42—Compressor and Condenser Hose Assembly (5.7L Engines)

4. Hose assembly (11) to condenser (9).



Tighten

- Hose assembly (11) to 24 N.m (18 lbs. ft.).

5. New O-ring seal (12).

- Coat O-ring seal with 525 viscosity refrigerant oil.

6. Hose assembly (11) to accumulator (6).



Tighten

- Hose assembly (11) to 41 N.m (30 lbs. ft.).

7. Sealing washers. Refer to "Compressor Sealing Washers."

8. Hose assembly (11) to the rear of the compressor (8).

NOTICE: Refer to "Notice" on page 1B-1.

9. Bolt (7).



Tighten

- Bolt (7) to 34 N.m (25 lbs. ft.).

10. Compressor support braces.

11. Auxiliary heater pipe, if equipped. Refer to SECTION 1A.

12. Refrigerant to the system.

- Check the system for leaks.

REAR AUXILIARY HOSE ASSEMBLY



Remove or Disconnect (Figures 41 through 45)

1. Discharge and recover refrigerant from the system.
2. Air cleaner assembly.
3. Evaporator tube (10) from auxiliary evaporator hose (15) (figure 41).
4. O-ring seal.

- Raise the vehicle and support with suitable safety stands.

5. Refrigerant hose assembly (11) from auxiliary compressor hose (21) (figure 43).
6. O-ring seal (22).
7. Right front wheelhouse. Refer to SECTION 2B.
8. Auxiliary evaporator hose (20) from auxiliary evaporator (26) (figure 44).
9. O-ring seal (25).
10. Auxiliary compressor hose (21) from auxiliary evaporator (26) (figure 44).
11. O-ring seal (25).
12. Screws (24).
13. Hose clips (23).
14. Auxiliary evaporator hose (20).
15. Auxiliary compressor hose (21).



Install or Connect (Figures 41 through 45)

NOTICE: For steps 4, 6, 8, 11, and 13, refer to "Notice" on page 1B-1.

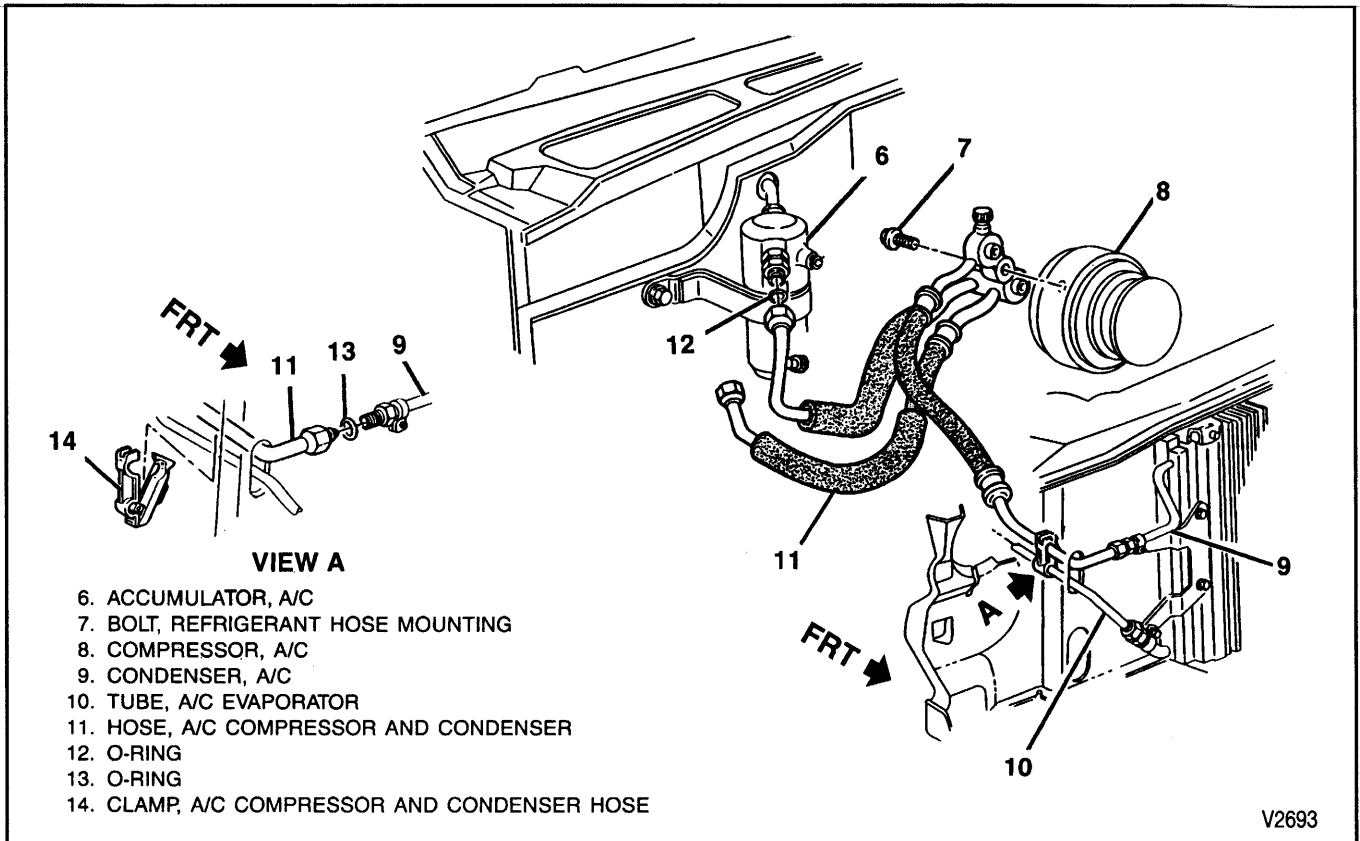


Figure 43—Compressor and Condenser Hose Assembly (7.4L Engines)

1. Auxiliary compressor hose (21).
2. Auxiliary evaporator hose (20).
3. Hose clips (23).
4. Screws (24).



Tighten

- Screws (24) to 6 N-m (53 lbs. in.).
5. New O-ring seal (25).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 6. Auxiliary compressor hose (21) to auxiliary evaporator (26) (figure 44).



Tighten

- Auxiliary compressor hose (21) to 32 N-m (24 lbs. ft.).
7. New O-ring seal (25).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 8. Auxiliary evaporator hose (20) to auxiliary evaporator (26) (figure 44).



Tighten

- Auxiliary evaporator hose (20) to 17 N-m (13 lbs. ft.).
9. Right front wheelhouse. Refer to SECTION 2B.
 10. New O-ring seal (22).
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 11. Refrigerant hose assembly (11) to auxiliary compressor hose (21) (figure 43).



Tighten

- Refrigerant hose assembly (11) to 24 N-m (18 lbs. ft.).
 - Lower the vehicle.
12. New O-ring seal.
 - Coat O-ring seal with 525 viscosity refrigerant oil.
 13. Evaporator tube (10) to auxiliary evaporator hose (15) (figure 41).



Tighten

- Evaporator tube (10) to 24 N-m (18 lbs. ft.).
14. Air cleaner assembly.
 15. Refrigerant to the system.
 - Check the system for leaks.

EVAPORATOR CORE



Remove or Disconnect (Figures 45 and 46)

1. Discharge and recover refrigerant from the system.
2. Rear quarter interior trim, as necessary. Refer to SECTION 10A4.
3. Right rear quarter trim panel. Refer to SECTION 10A4.
4. Right rear wheelhouse. Refer to SECTION 2B.
5. Rear heater hoses from auxiliary heater core (32), if equipped. Refer to SECTION 1A.

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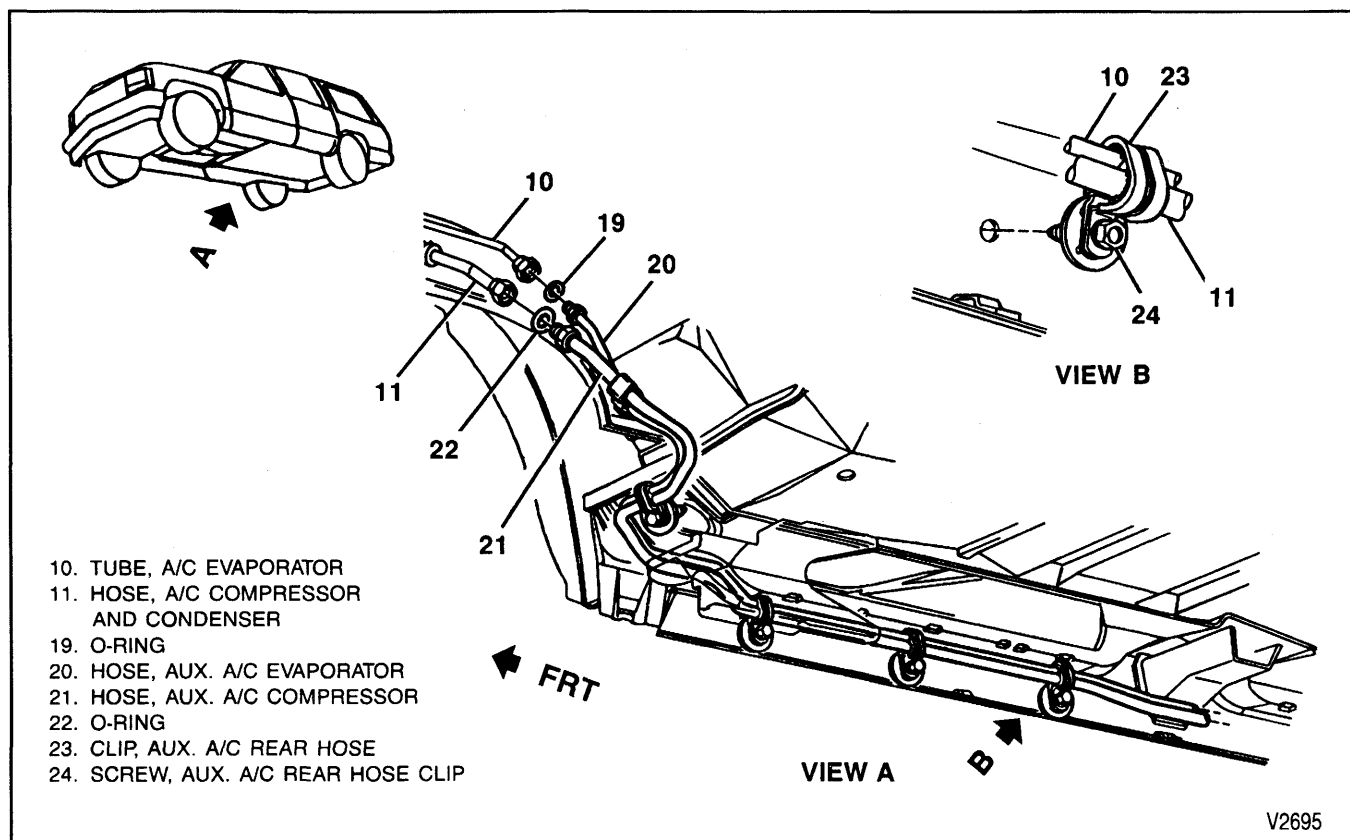


Figure 44—Auxiliary Compressor and Condenser Hose Routing

6. Auxiliary refrigerant hoses (20 and 21) from auxiliary evaporator (26). Refer to "Compressor and Condenser Hose Assembly."
7. Electrical connectors, as necessary.
8. Heater/evaporator case cover.
9. Evaporator core (26).

Install or Connect (Figures 45 and 46)

1. Evaporator core (26). Refer to "Refrigerant Oil Distribution," if replacing evaporator.
2. Heater/evaporator case cover.
3. Electrical connectors, as necessary.
4. Auxiliary refrigerant hoses (20 and 21) to auxiliary evaporator (26). Refer to "Compressor and Condenser Hose Assembly."
5. Rear heater hoses to auxiliary heater core (32), if equipped. Refer to SECTION 1A.
6. Right rear wheelhouse. Refer to SECTION 2B.
7. Right rear quarter trim panel. Refer to SECTION 10A4.
8. Rear quarter interior trim, as necessary. Refer to SECTION 10A4.
9. Refrigerant to the system.
 - Check the system for leaks.

BLOWER MOTOR RESISTOR

Remove or Disconnect (Figure 46)

1. Negative battery cable. Refer to SECTION 0A.
2. Right rear quarter trim panel cover. Refer to SECTION 10A4.

3. Electrical connectors, as necessary.
4. Screws (30).
5. Blower motor resistor (31).

Install or Connect (Figure 46)

1. Blower motor resistor (31).

NOTICE: Refer to "Notice" on page 1B-1.

2. Screws (30).

Tighten

- Screws (30) to 1.4 N·m (12 lbs. in.).

3. Electrical connectors, as necessary.
4. Right rear quarter trim panel cover. Refer to SECTION 10A4.
5. Negative battery cable.

- Check circuit operation.

BLOWER MOTOR AND FAN

Remove or Disconnect (Figure 46)

1. Negative battery cable. Refer to SECTION 0A.
2. Right rear quarter trim panel cover. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.
4. Screws (29).
5. Blower motor (28).

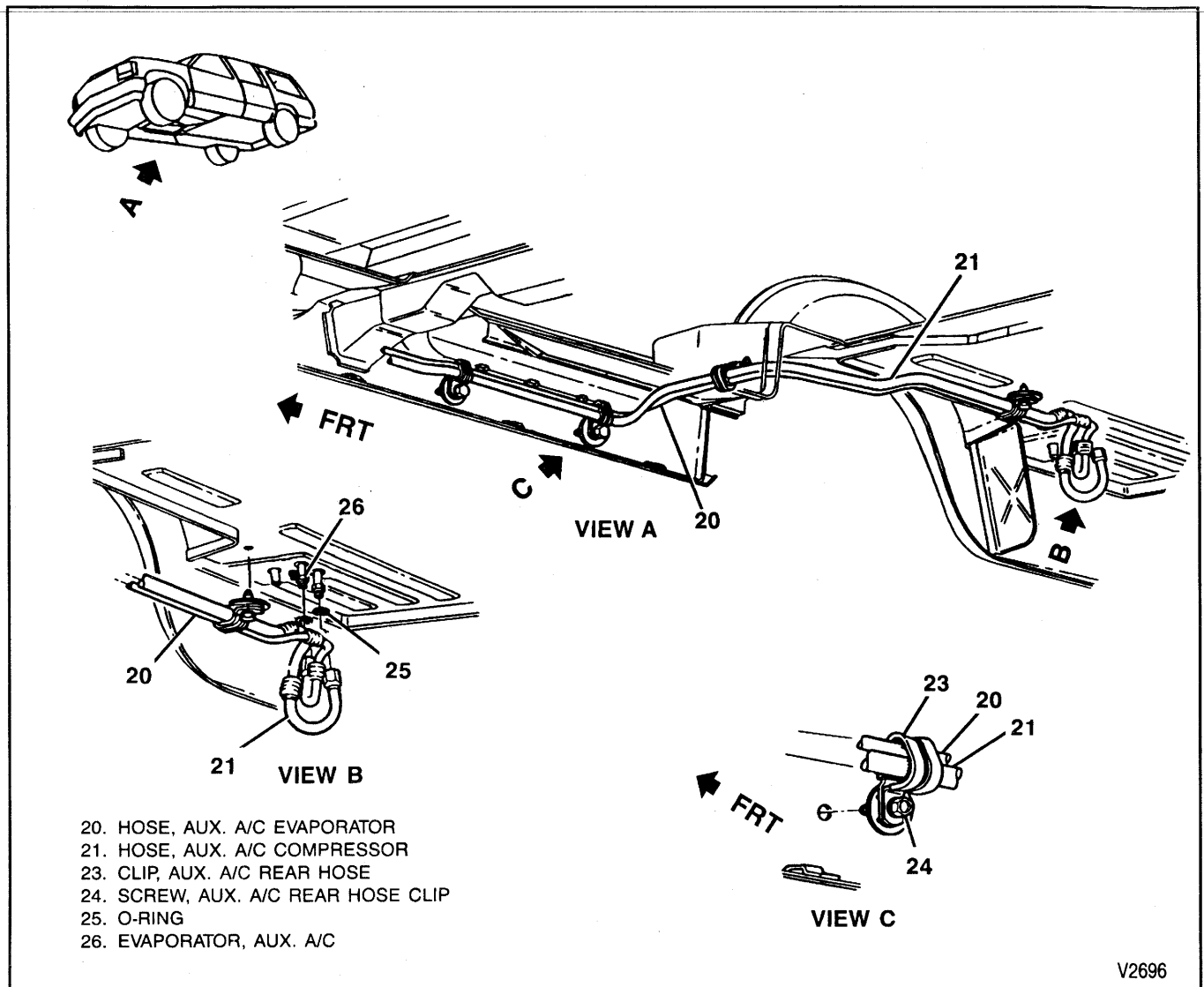


Figure 45—Auxiliary Refrigerant Hose Routing

Install or Connect (Figure 46)

1. Blower motor (28).

NOTICE: Refer to "Notice" on page 1B-1.

2. Screws (29).

Tighten

- Screws (29) to 1.4 N·m (12 lbs. in.).
3. Electrical connectors, as necessary.
 4. Right rear quarter trim panel cover. Refer to SECTION 10A4.
 5. Negative battery cable.
 - Check circuit operation.

1B-46 HEATER, VENTILATION, AND AIR CONDITIONING

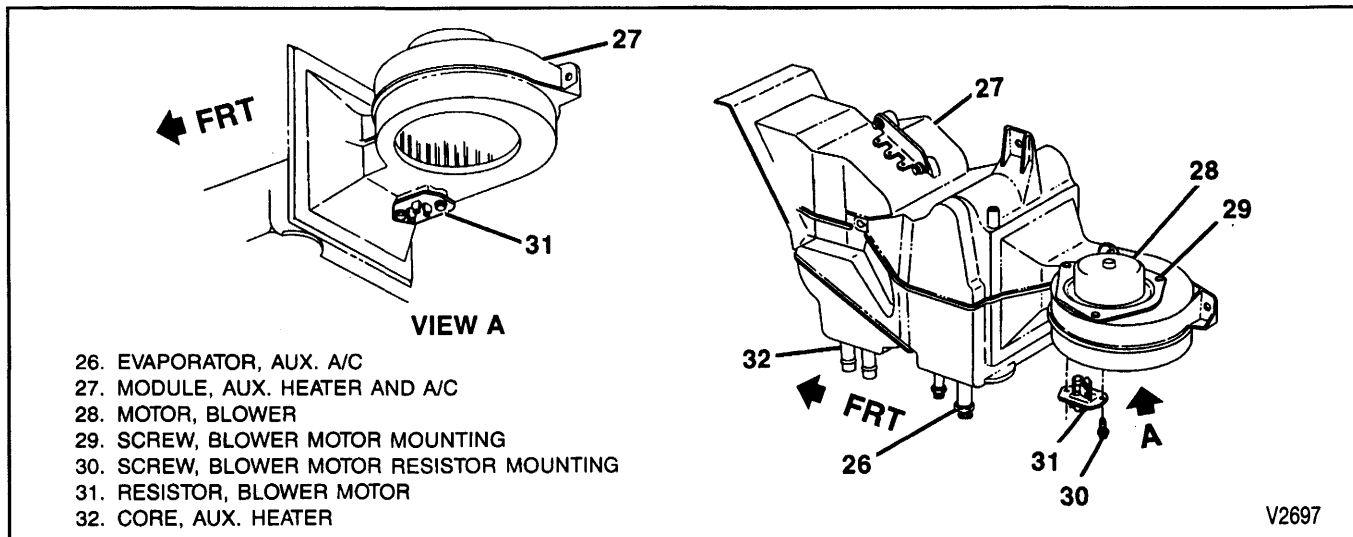


Figure 46—Auxiliary Heater Module

SPECIFICATIONS

GENERAL SPECIFICATIONS

Compressor	Harrison HR110-MD
Type	4 Cylinder Axial
Displacement	11.0 Cu. In.

SYSTEM CAPACITIES

Refrigerant-134a	
Pickup Models	0.91 kg (2.0 lbs.)
Crew Cab, Suburban, and Utility Models	1.02 kg (2.25 lbs.)
Suburban with Aux. A/C	1.81 kg (4.0 lbs.)
Polyalkaline Glycol (PAG) Refrigerant Oil	
Without Aux. A/C	240 ml (8 fl. oz.)
With Aux. A/C	330 ml (11 fl. oz.)

FASTENER TIGHTENING SPECIFICATIONS

Accumulator Bracket Mounting Screw	6 N·m (53 lbs. in.)
Accumulator-to-Evaporator	41 N·m (30 lbs. ft.)
Auxiliary Blower Motor Resistor Mounting Screw (C69)	1.4 N·m (12 lbs. in.)
Auxiliary Compressor Hose Mounting Clip Screws (C69)	6 N·m (53 lbs. in.)
Auxiliary Compressor Hose-to-Auxiliary Evaporator (C69)	32 N·m (24 lbs. ft.)
Auxiliary Evaporator Hose-to-Auxiliary Evaporator (C69)	17 N·m (13 lbs. ft.)
Blower Motor Mounting Screw	1.7 N·m (15 lbs. in.)
Blower Motor Resistor Mounting Screw	1.4 N·m (12 lbs. in.)
Compressor Bracket Mounting Bolts (6.2L, 6.5L)	40 N·m (30 lbs. ft.)
Compressor Bracket Mounting Bolts (7.4L)	50 N·m (37 lbs. ft.)
Compressor Bracket Mounting Nuts (6.2L, 6.5L)	23 N·m (17 lbs. ft.)
Compressor Mounting Bolts (4.3L, 5.0L, and 5.7L)	33 N·m (24 lbs. ft.)
Condenser Mounting Screw	4.5 N·m (40 lbs. in.)
Control Assembly Mounting Screw	1.9 N·m (17 lbs. in.)
Cowl Panel-to-Module Assembly Screw	1.9 N·m (17 lbs. in.)
Defroster Nozzle Mounting Screw	1.9 N·m (17 lbs. in.)
Defroster Nozzle-to-Heater Case Mounting Screw	1.4 N·m (12 lbs. in.)
Distributor Duct Mounting Screw	1.9 N·m (17 lbs. in.)
Evaporator Tube-to-Auxiliary Evaporator Hose (C69)	24 N·m (18 lbs. ft.)
Evaporator Tube-to-Condenser	24 N·m (18 lbs. ft.)
Evaporator Tube-to-Evaporator	24 N·m (18 lbs. ft.)
Module Assembly-to-Cowl Panel Nut	2.8 N·m (25 lbs. in.)
Module Assembly-to-Cowl Panel Screw	11 N·m (97 lbs. in.)
Pressure Cycling Switch-to-Accumulator	4.5 N·m (40 lbs. in.)
Refrigerant Hose-to-Accumulator	41 N·m (30 lbs. ft.)
Refrigerant Hose-to-Auxiliary Compressor Hose	24 N·m (18 lbs. ft.)
Refrigerant Hose-to-Compressor Bolt	34 N·m (25 lbs. ft.)
Refrigerant Hose-to-Condenser	24 N·m (18 lbs. ft.)
Support Bracket-to-Compressor Bracket Bolt (7.4L)	84 N·m (62 lbs. ft.)
Support Bracket-to-Engine Bolt (7.4L)	65 N·m (48 lbs. ft.)

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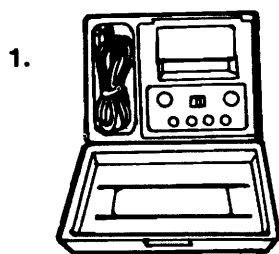
1B-48 HEATER, VENTILATION, AND AIR CONDITIONING

R134A METRIC FITTING SIZES

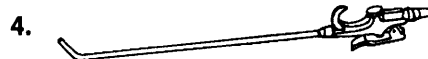
RPO	HEX FITTING SIZE (mm)	CONNECTION	B/U HEX FITTING SIZE (mm)	TORQUE (N·m)
C60/C69	24	A/C Cond. Hose to Cond. Inlet		27.5 +/- 7.5
C60/C69	24	Evap. Tube to Cond. Outlet		27.5 +/- 7.5
C60/C69	22	Evap. Tube to Module	20	27.5 +/- 7.5
C60/C69	32	A/C Accum. to Module	27	45.0 +/- 7.0
C60/C69	27	A/C Comp. Hose to A/C Accum.	N/A	45.0 +/- 7.0
C69	32	Aux. Comp. Hose (Female) to A/C Comp. Hose (Male Brazed)	27	45.0 +/- 7.0
C69	24	Aux. Evap. Hose (Female) to Evap. Tube (Male Brazed)	20	27.5 +/- 7.5
C69	22	Aux. Evap. to Aux. Module	16	16.5 +/- 1.5
C69	26	Aux. Comp. to Aux. Module	22	32.0 +/- 4.0

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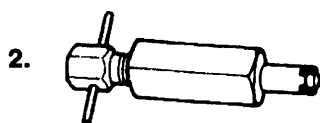
SPECIAL TOOLS



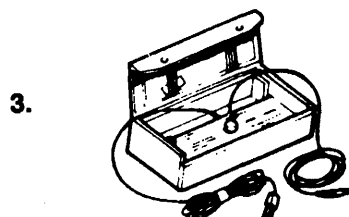
J 21213-A



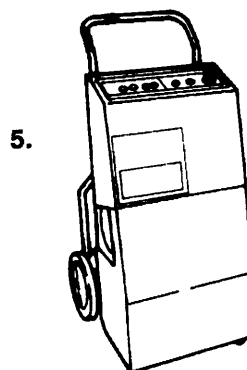
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J 26549-D



J 39400



J 39500



J 39037

1. FOUR JACK-DUAL RANGE TEMPERATURE TESTER
2. ORIFICE TUBE REMOVER AND EXTRACTOR
3. H-10 LEAK DETECTOR
4. EVAPORATOR CLEANING GUN
5. REFRIGERANT RECOVERY, RECYCLING, AND RECHARGING STATION
6. CHARGE VALVE OCTAGON SOCKET

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SECTION 2

FRAME AND SHEET METAL

CONTENTS

<u>SUBJECT</u>	<u>PAGE</u>
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Sheet Metal	2B-1

SECTION 2A

FRAME AND BUMPERS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

Proper frame alignment is critical to ensure normal life and functioning of many parts of the vehicle. If the vehicle has been involved in a fire, collision, or has been overloaded, check the frame alignment. If, for any other reason, misalignment is suspected, it should be checked. Refer to "Checking Frame Alignment" later in this section.

It is possible that certain conditions make the frame appear to be out of alignment when, in fact, it is not. These conditions are also described under "Checking Frame Alignment."

Terms used later in this section are briefly defined below:

1. **SECTION MODULUS** is a measure of frame strength based on height, width, thickness, and shape of the side rails. It does not account for the strength of the material used in the frame.
2. **YIELD STRENGTH** is a measure of material strength from which the frame is made. It is the maximum load measure in kPa (psi) that can be placed on a material and still have it return to its original shape.
3. **RESISTANCE TO BENDING MOMENT (RBM)** is a single measure of frame strength that accounts for both the section modulus and the strength of the material used. It is the product of section modulus and yield strength.
4. **SAG** refers to a frame or side rail that is bent down from where it should be.
5. **BUCKLE** refers to a frame or side rail that is bent up from where it should be.
6. **DIAMOND** refers to the condition where one frame rail is moved forward from, or to the rear of, its correct alignment with the other rail.
7. **TWIST** refers to the condition where the entire frame has been twisted. One rail will slope up while the other rail will slope down.
8. **SIDESWAY** refers to a side rail that is bent to the side of where it should be.
9. **TRACKING** refers to the alignment of the vehicle axles with each other. A misaligned frame can cause improper tracking. If the vehicle is tracking correctly, all axles will be parallel to each other and perpendicular to the centerline of frame.
10. **WEB** refers to the vertical part of a channel-type frame rail.

DIAGNOSIS OF THE FRAME

PROBLEM	POSSIBLE CAUSE	CORRECTION
Sag	1. Loads greater than the frame is designed to carry. 2. Uneven load distribution. 3. Abrupt changes in section modulus. (For a brief definition of section modulus, see the "Description" at the beginning of this section). 4. Improper body, or accessory, mounting: — Holes drilled in the flange of the frame rail. — Too many holes in the web section of the rail. — Holes in the web section which are too close to each other. — Four or more holes in the same vertical line of the rail web. — Welds on the flange, particularly across the flange or along its edge. — Cutting holes in the rail with a torch. — Cutting notches anywhere on the rails. 5. A fire involving the vehicle. 6. A collision involving the vehicle. 7. The use of equipment for which the frame has not been designed or reinforced.	1-7. Straighten and reinforce the frame as described later in this section. See "Straightening Frames" and "Reinforcements."

DIAGNOSIS OF THE FRAME (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Buckle	1. The use of equipment such as snow plows for which the frame was not designed. 2. A collision involving the vehicle. 3. A fire involving the vehicle. 4. In addition to these causes, refer to possible causes 3 and 4 under "Sag."	1-4. Straighten and reinforce the frame as described later in this section. See "Straightening Frames" and "Reinforcements."
Sidesway	1. A collision involving the vehicle. 2. A fire involving the vehicle. 3. The use of equipment such as snow plows for which the frame was neither designed nor properly reinforced. 4. In addition to these causes, refer to possible causes 3 and 4 under "Sag."	1-4. Straighten and reinforce the frame as described later in this section. Refer to "Straightening Frames" and "Reinforcements."
Diamond	1. A collision involving the vehicle. 2. Towing another vehicle with a chain attached to one corner of the frame.	1-2. Straighten and reinforce the frame as described later in this section. Refer to "Straightening Frames" and "Reinforcements."
Twist	1. An accident or collision involving the vehicle. 2. Operating the vehicle in very rough terrain.	1-2. Straighten and reinforce the frame as described later in this section. Refer to "Straightening Frames" and "Reinforcements."
Improper Tracking	1. Frame is out of alignment. 2. Front or rear axle has shifted. 3. Incorrect wheel alignment may make the vehicle appear to be tracking incorrectly.	1. Straighten and reinforce the frame as described later in this section. 2. Realign and secure the axle. 3. Align the wheels. Refer to SECTION 3A.
Cracks In The Web Of The Rails	1. Loose crossmember attaching bolts. 2. Concentration of stress that may result from many different factors. Refer to "Sag". Also refer to "Minimizing Frame Damage" and "Reinforcements" later in this section.	1. Replace, or weld and reinforce rail. Ream bolt holes and replace with larger bolts if necessary. Retighten bolts. 2. Replace, or weld and reinforce the rail. See the appropriate heading, later in this section.
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MINIMIZING FRAME SERVICE

Generally, frame service can be minimized or eliminated by minimizing the concentration of stress in small areas of the frame.

1. Vehicles should be used only for those purposes for which they were designed.
 - They should not be overloaded.
 - They should be loaded evenly; localized loads should be avoided.
 - Do not operate the vehicle on extremely rough terrain.
 - Take into account the forces that will be placed on a frame from the operation of equipment such as snow plows when picking a frame for a new vehicle or reinforcing a frame.

2. Follow recommended practices when repairing a frame or when mounting a body or equipment on a frame.

- Avoid sudden changes in the section modulus.
- Do not drill holes in the frame rail flanges.
- Space holes in the web section of a rail at least 13 mm (1/2 inch) from one another.
- Use existing holes whenever possible.
- Do not cut holes with a torch.
- Do not overheat the frame rails.
- Avoid welding on the flanges.
- Do not allow four or more holes to exist on the same vertical line of the web.

2A-4 FRAME AND BUMPERS

- Holes made in a reinforcement should be placed a distance of at least two times the material thickness from the edge of the reinforcement.

CHECKING FRAME ALIGNMENT

The main parts of a frame are the side rails and crossmembers. The rails carry the load and the crossmembers stabilize the rails.

Types of frame misalignment can be divided into five groups. The five groups are sag, buckle, diamond, sidesway, and twist. For a brief definition of these terms, refer to "General Description" at the beginning of this section.

A misaligned frame rail may have moved forward from, up or down from, or to the side of where it should be. These possibilities must be investigated.

The easiest way to check frame alignment is with tramming gages made for this purpose. Detailed instructions are normally supplied with gages at the time of purchase. Therefore, instructions for gage use are not given in this manual.

It is possible to check certain portions of frame alignment without the proper gages. The procedure is described later in this section.

Whether alignment is checked with or without gages, the vehicle must be parked on a level section of floor.

Certain conditions call for preliminary checks before actually checking the frame. Suspension or axle problems may make it appear that the vehicle frame is out of alignment. If an axle has shifted, "Diamond" or "Sidesway" may appear to exist when, in fact, they do not. A weak spring may make the vehicle appear to have a twisted frame.

A visual inspection of the top and bottom flanges of each rail may reveal the specific area where sag or buckle exists. In the case of sag, wrinkles may appear on the top of the upper flange; such wrinkles are definite evidence of sag. Wrinkles on the bottom of the lower flange are definite evidence of buckle.

DETERMINING THE FRAME CENTERLINE

1. Move the vehicle to a level, well-lighted section of the floor.
2. Make a diagram of the frame on the floor beneath the vehicle as follows:
 - a. Using a plumb bob, transfer points 1, 2, 11, and 12 from the inside of the web to the floor. Mark the points (figure 1).
 - b. Using a plumb bob, transfer the remaining points from the outside of the web to the floor. Mark the points. The actual placement of these points is not so important as is the fact that the points must be taken from the same place on both the right and left frame rail.
3. Move the vehicle away from the points on the floor.
4. Measure the distance from the outer edge of each frame rail at points 1 and 2. This distance should be 866 mm (35.31 inches).
5. Measure the distance from the dead center of each frame rail at points 11 and 12. This distance should be 860 mm (33.85 inches).

6. Make a mark on the floor exactly halfway between points 1 and 2. Make a similar mark between points 11 and 12.
7. Use a chalk line to mark a line through the points. This is the centerline of the frame.

HORIZONTAL CHECK

1. Measure the distance between the frame rails, and the centerline at points 3-10. Each pair of corresponding points should be an equal distance from the centerline within 3 mm (1/8 inch). Example: Points 3 and 4 should measure equally from the centerline as should points 5 and 6, 7 and 8, and points 9 and 10.
2. Measure diagonally from point 1 to point 6, and from point 2 to point 5. Mark the floor where the diagonals pass the centerline. The diagonals should measure the same distance within 5 mm (3/16 inch), and should cross at the centerline. If the frame is within specifications, the frame within these points is properly aligned.
3. Repeat step 2 on other pairs of diagonals until the entire frame has been checked. Example: Point 3 to point 10 and point 4 to point 9 or point 5 to point 12 and point 6 to point 11, etc.
4. Refer to "Straightening Frames" to repair any damage that is found.

STRAIGHTENING FRAMES

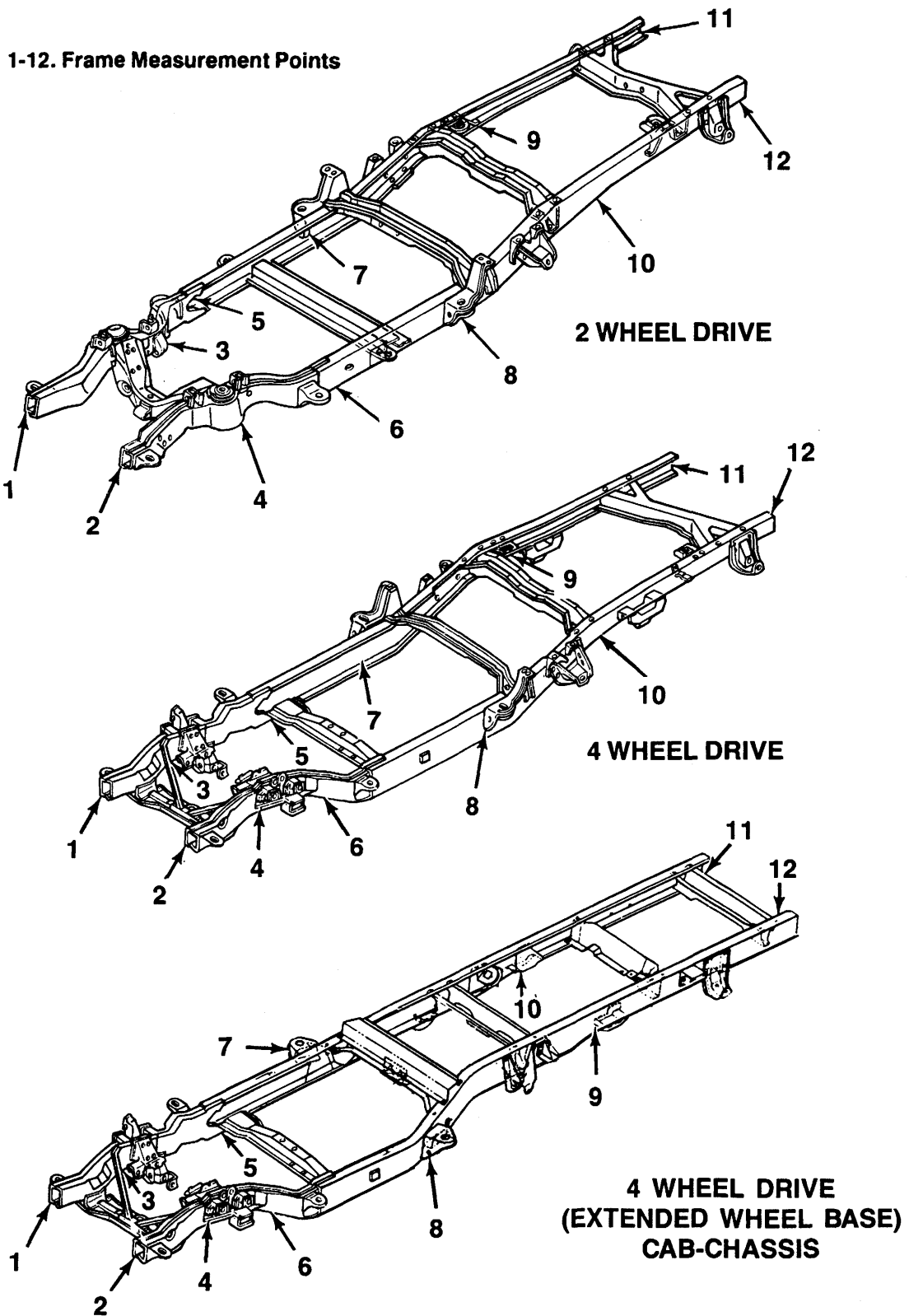
Frame straightening can be complicated and usually requires special equipment. It should be attempted by trained personnel only.

A complete analysis of the condition of the frame should be made before any steps are taken to straighten it. Analyzing the cause of failure will help determine the correct sequence of steps in the repair. (Refer to "Possible Causes" under "Diagnosis" and "Minimizing Frame Service" previously outlined in this section.) Use corrective procedures to reverse the flow of the damaging forces. In many instances, to reverse the flow of forces, pressure must be applied from different directions at the same time.

Careful use of controlled heat is critical. Too much or too little heat, or the improper application of heat, is a major source of trouble. Frame heating should be done with a large sized (multi-hole heating tip) and a neutral flame should be used (oxygen adjustment opened just enough to remove the feathers or stringers from the blue center at tip of torch). Heat the area that will be stretched as the frame is straightened. Heat the area AFTER SUFFICIENT PRESSURE HAS BEEN EXERTED to cause a slight checking, or silvery cracks, to appear on the surface of the metal. Gradually increase the pressure while heating. Do not heat beyond 606° C (1200° F). A red glow indicates that the material is overheated. Overheating will cause distortion and stretching, as well as a change in the characteristics of the metal.

REPAIRING CRACKS

Two common types of cracks are shown in figure 2. The straight crack will normally start from the edge of a flange. It will go across the flange and through the web section of a rail. Finally, it will continue through the other flange. This type of crack may result from high



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Figure 1—Frame Measuring Points

2A-6 FRAME AND BUMPERS

concentrations of stress in small areas of the frame, excessive bending moment, and torsional loading. (Refer to "Minimizing Frame Service," previously outlined in this section).

Sunburst crack(s) will radiate outward from a hole in the web section of a rail or crossmember. They are caused by high loads being applied at a mounting bracket or crossmember which is not securely or properly attached to the rail.

If cracks occur to both the rail and reinforcement at a particular area of the frame, they must be repaired separately. The flanges must react independently to prevent localized stress concentration. Use a copper spacer between the flanges of cracked base rail flanges and reinforcement flanges.

Crossmember mounting flange cracks may be repaired in the same manner as side rail cracks. However, weld bead should be built up to provide a good, smooth radius. If a crossmember is badly damaged, replace it.

It may be necessary to align the frame and level the rails before repairing the frame.

1. Remove any equipment that will interfere with access to the crack.
2. Locate the extreme end of the crack and drill a 6-mm (0.25 -inch) hole.
3. "V" grind the entire length of the crack from the starting point to the 6-mm (0.25-inch) hole at the extreme end.
4. Open up the bottom of the crack 2 mm (1/16 inch) to allow good penetration of the weld. (A hacksaw blade may be used for this).
5. Weld with proper electrode and proper welding techniques. Refer to "Welding" outlined later in this section for tips on welding.
6. Grind the weld smooth on both the inside and the outside of the rail or crossmember. Be extremely careful to eliminate weld buildup or notches on the edge of the flange.

WELDING

Using improper welding techniques causes many weld and/or frame failures. The following information points out potential areas of difficulty and provides some general guidelines for successful frame welding.

Most weld failures occur at the end of the weld in areas of the frame that are under high stress. By eliminating the ends of a weld, failures can be reduced. This can be done by making a hole or slot in the part to be attached and then using a fillet weld around a slot or plug weld. Do not leave a notch at the end of a weld.

Over-welding can be harmful, especially if it is in an area of the frame that receives high concentrations of stress.

Small cracks in a crossmember may be welded. (Refer to "Repairing Cracks" previously outlined in this section).

When Welding:

1. Disconnect the vehicle battery(ies).
2. The frame is covered with a protective wax coating. Use a wire brush to remove any concentration of wax before welding. When finished, recoat the area with new wax.

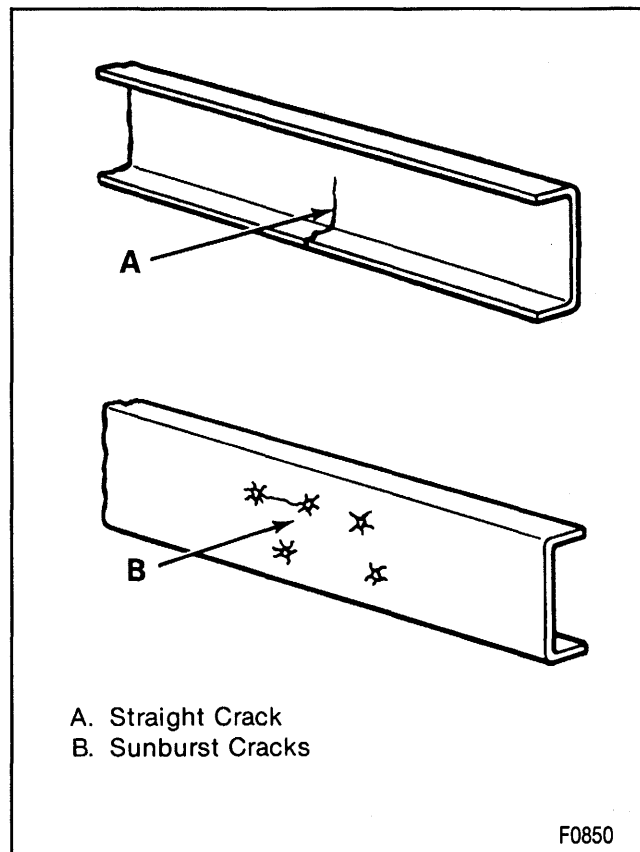


Figure 2—Types of Frame Cracks

3. Do not use oxyacetylene welding equipment.
4. Whenever possible, use smaller diameter electrodes and make several passes; this is preferred to using a large diameter electrode and making fewer passes.
5. Do not use more heat than is necessary to give good penetration.
6. Do not run more passes than necessary.
7. Make sure the weld is free from craters and undercuts.
8. Make sure scale is removed from each successive pass.
9. If repairing a crack, grind the surface of the weld flush with the parent material.
10. When mounting accessories, do not weld across the flanges.
11. When mounting accessories, do not weld within 19 mm (3/4 inch) of a flange.
12. Do not weld up to the edge of a part being welded to a frame. Leave 6 mm (0.25 inch) between the end of the weld and the edge of the part.
13. Do not weld cast brackets to the frame.
14. Do not weld the flanges of cracked reinforcements and base rails together.
15. Do not attach the ground cable to the engine. Connect the welding machine ground cables as close to the working area as possible.
16. Do not get the welding cables near the vehicle wiring. Avoid direct contact between the welding cables and any part of the vehicle.

ON-VEHICLE SERVICE

FRONT AIR DEFLECTOR REPLACEMENT

↔ Remove or Disconnect (Figure 3)

1. Deflector to the bumper bolts.
2. Deflector from the vehicle.

→ Install or Connect (Figure 3)

1. Deflector to the vehicle.

NOTICE: Refer to "Notice" on page 2A-1.

2. Deflector to the bumper bolts.

⌚ Tighten

- Deflector to the bumper bolts to 10 N·m (89 lbs. in.).

FRONT BUMPER REPLACEMENT

↔ Remove or Disconnect (Figures 4 and 5)

1. Bumper to brace bolts and washers (figure 4).
2. Bumper to bracket bolts and washers.
3. Bumper from the vehicle.

4. Guards from the bumper (if equipped) (figure 5).
5. Air deflector from the bumper (if equipped). Refer to "Front Air Deflector Replacement."

→ Install or Connect (Figures 4 and 5)

NOTICE: For steps 2, 4, and 5, refer to "Notice" on page 2A-1.

1. Air deflector to the bumper. Refer to "Front Air Deflector Replacement."
2. Guards to the bumper with nuts (if equipped).

⌚ Tighten

- Guard to the bumper nuts to 25 N·m (18 lbs. ft.).

3. Bumper to the vehicle.
4. Bumper bolts and washers to the bracket.
5. Bumper bolts and washers to the brace.

- Align the bumper laterally to the grille area.

⌚ Tighten

- Bumper to the bracket and the brace bolts to 112 N·m (83 lbs. ft.).

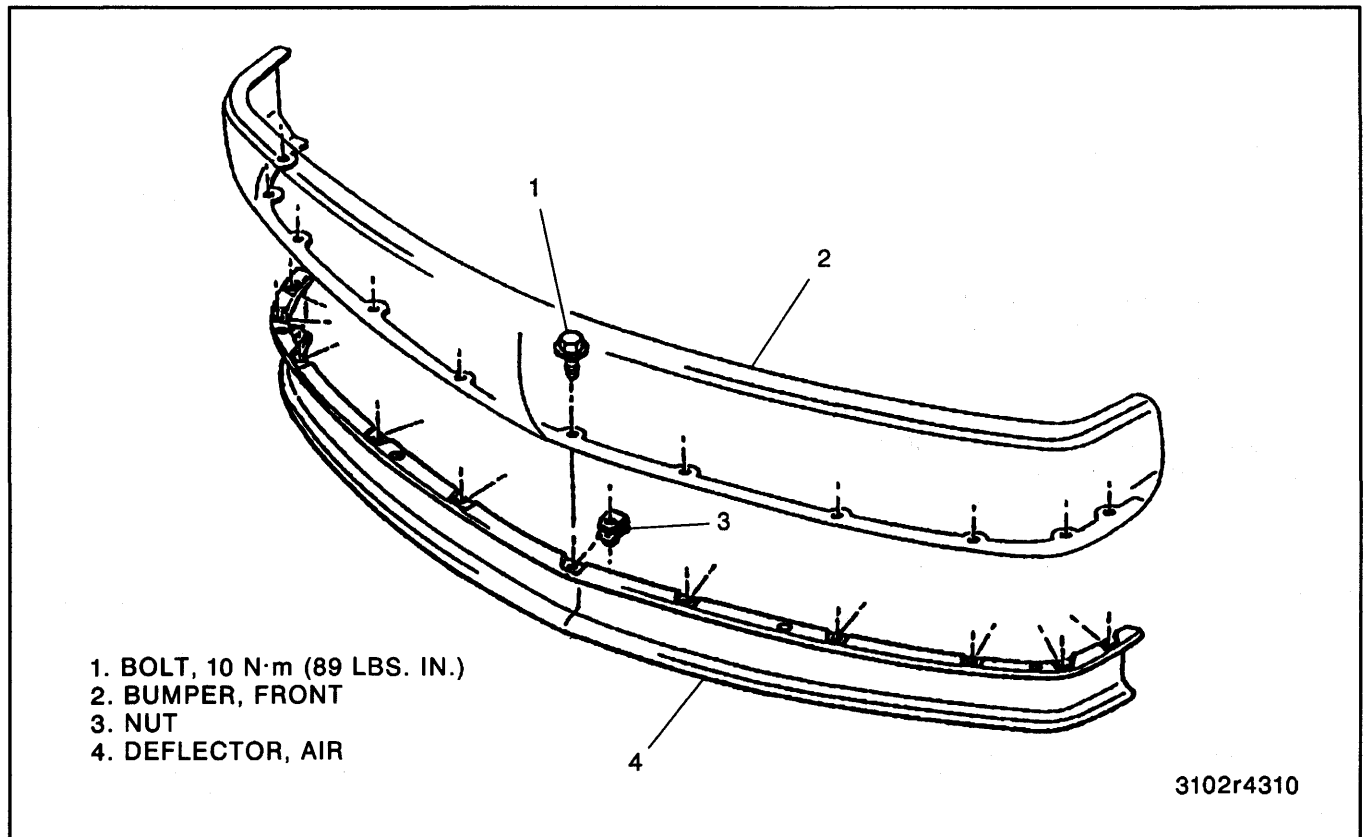


Figure 3—Front Air Deflector

2A-8 FRAME AND BUMPERS

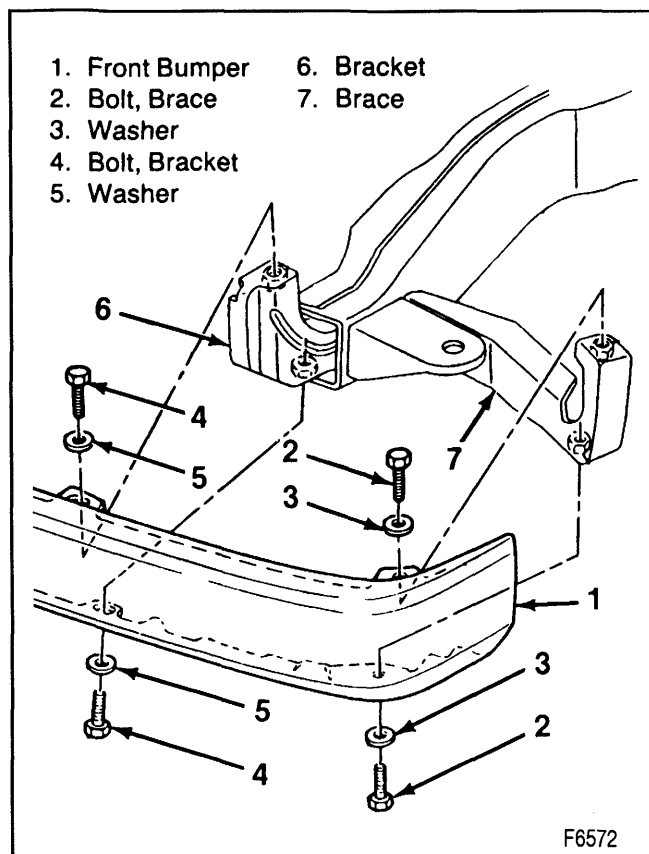


Figure 4—Front Bumper

FRONT BUMPER FILLER CENTER PANEL REPLACEMENT

↔ Remove or Disconnect (Figure 6)

1. Grille. Refer to SECTION 2B.
2. Filler panel to the radiator support screws.
3. Filler center panel from the vehicle.

↔ Install or Connect (Figure 6)

1. Filler panel to the vehicle.
2. Filler panel to the radiator support screws.

⌚ Tighten

- Panel to support screws to 1.9 N.m (17 lbs. in.).

3. Grille to the vehicle. Refer to SECTION 2B.

FRONT BUMPER FILLER SIDE PANEL REPLACEMENT

↔ Remove or Disconnect (Figure 6)

1. Filler panel to the fender bolts.
2. Filler side panel.

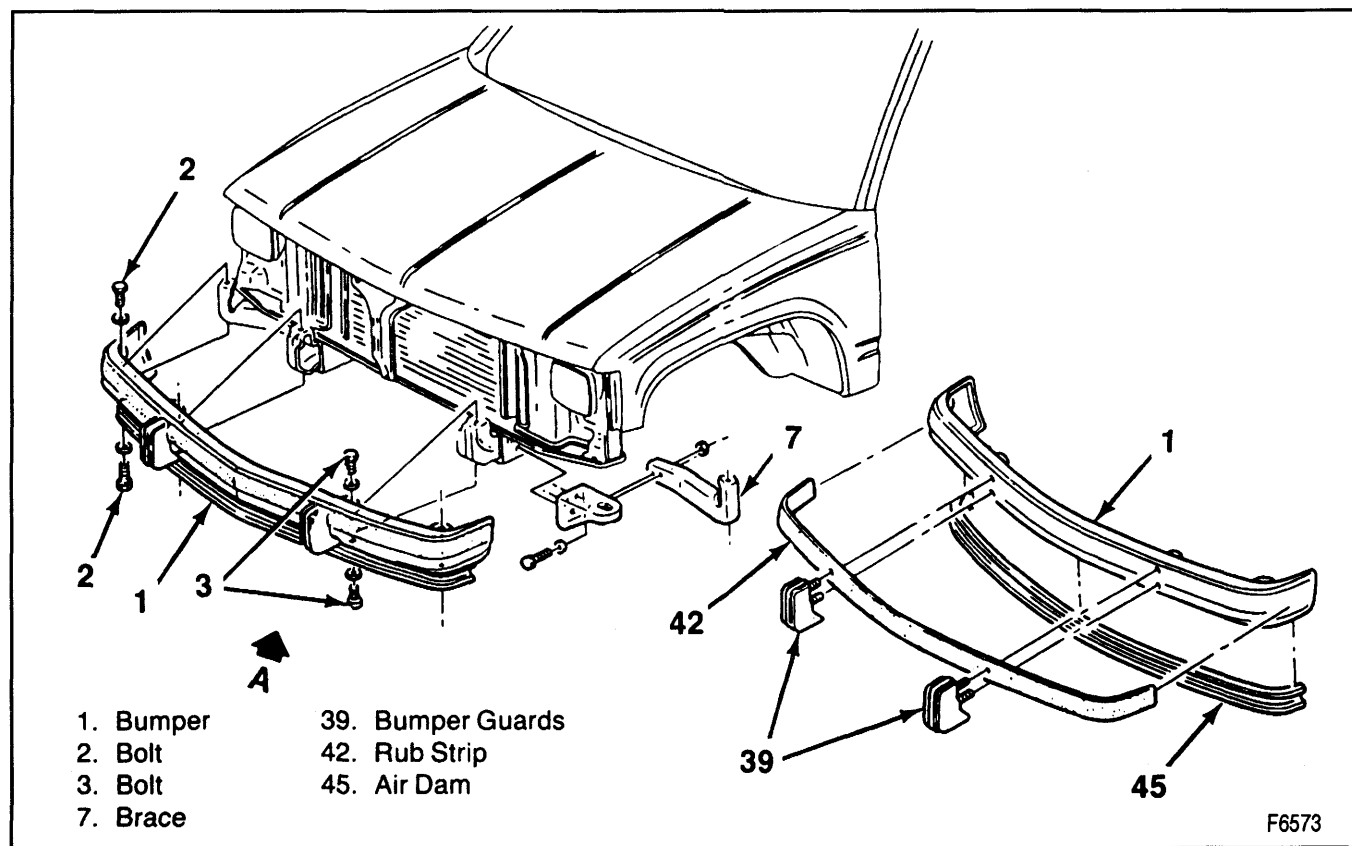


Figure 5—Bumper Assembly Components

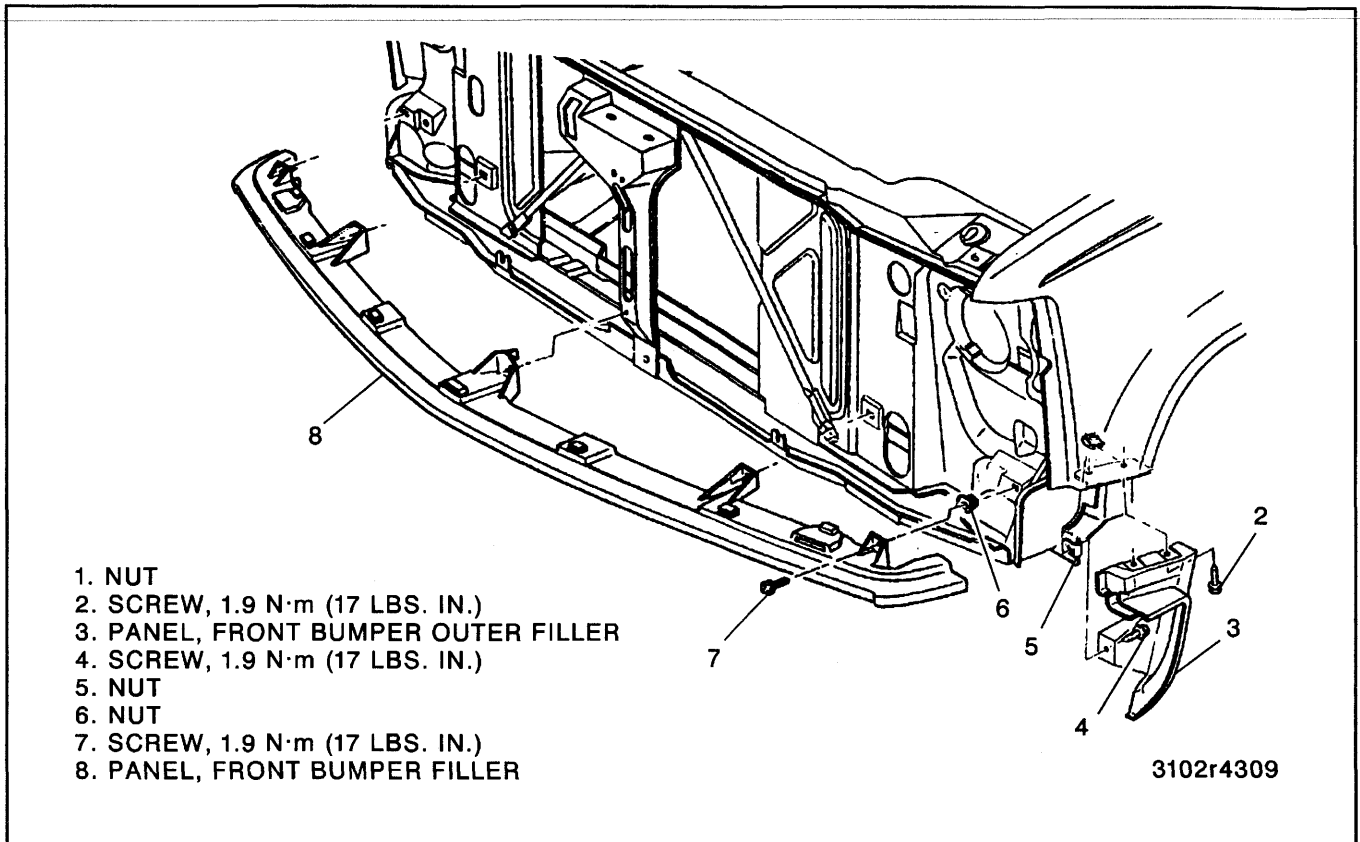


Figure 6—Front Bumper Filler Panels

Install or Connect (Figure 6)

1. Filler side panel.
2. Filler panel to the fender bolts.

Tighten

- Panel to fender bolts to 1.9 N·m (17 lbs. in.).

FRONT LICENSE PLATE BRACKET REPLACEMENT

Remove or Disconnect (Figure 7)

1. License plate bracket to the bumper nuts.
2. License plate bracket to the bumper bolts.
3. License plate bracket.

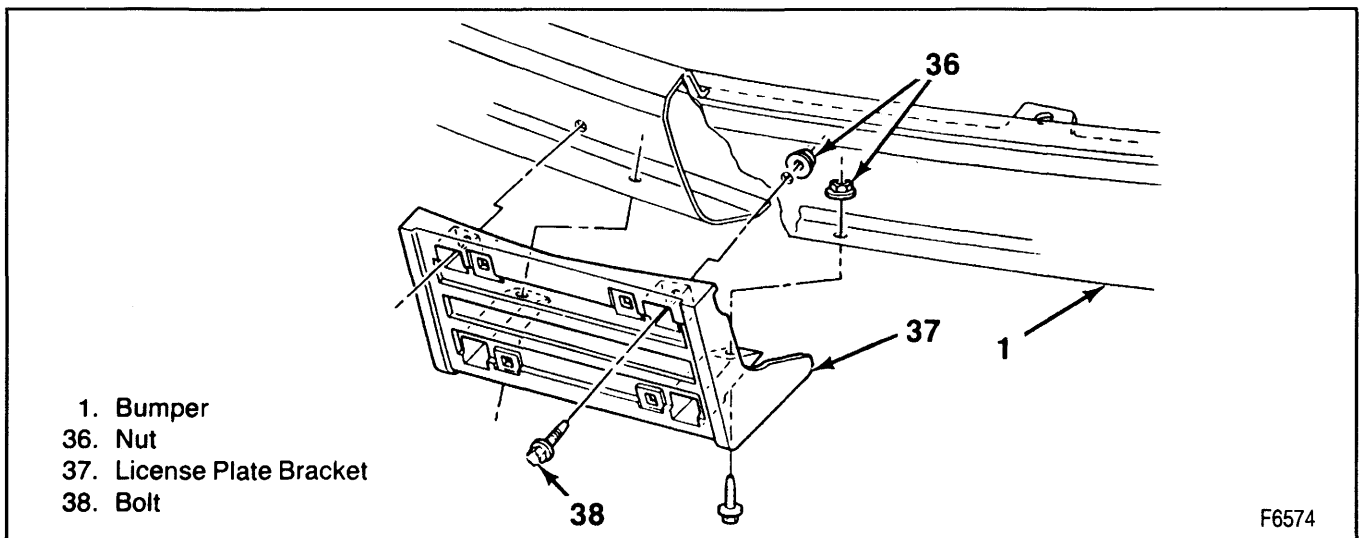
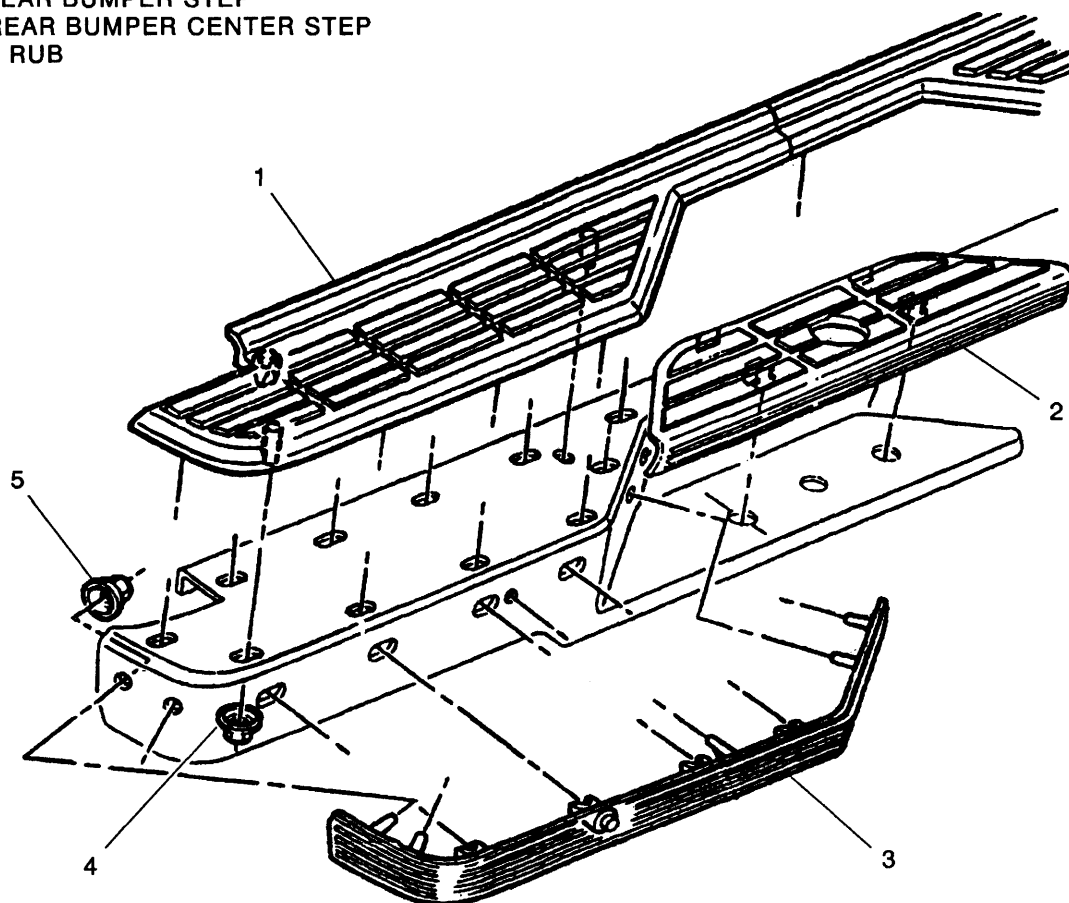


Figure 7—Front License Plate Bracket

2A-10 FRAME AND BUMPERS

1. PAD, REAR BUMPER STEP
2. PAD, REAR BUMPER CENTER STEP
3. STRIP, RUB
4. NUT
5. NUT



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Figure 8—Rear Bumper Step Pads and Rub Strips

↔ Install or Connect (Figure 7)

1. License plate bracket.
2. License plate bracket to the bumper bolts.



Tighten

- License plate bracket to the bumper bolts to 12.5 N·m (111 lbs. in.).
- 3. License plate bracket to the bumper nuts.

REAR BUMPER STEP PAD REPLACEMENT

↔ Remove or Disconnect (Figure 8)

1. Step pad to bumper nuts.
2. Step pad.



Install or Connect (Figure 8)

1. Step pad to bumper.
2. Step pad to bumper nuts.

REAR BUMPER REPLACEMENT



Remove or Disconnect (Figures 9 and 10)

1. License plate lamp harness. Refer to SECTION 8B.
2. Brace to bumper nuts and bolt assemblies.
3. Bracket to bumper nuts, washers and bolts.
4. Bumper from the vehicle.
5. Brace and bracket nuts, washers and bolts.
6. Braces and brackets from the frame.

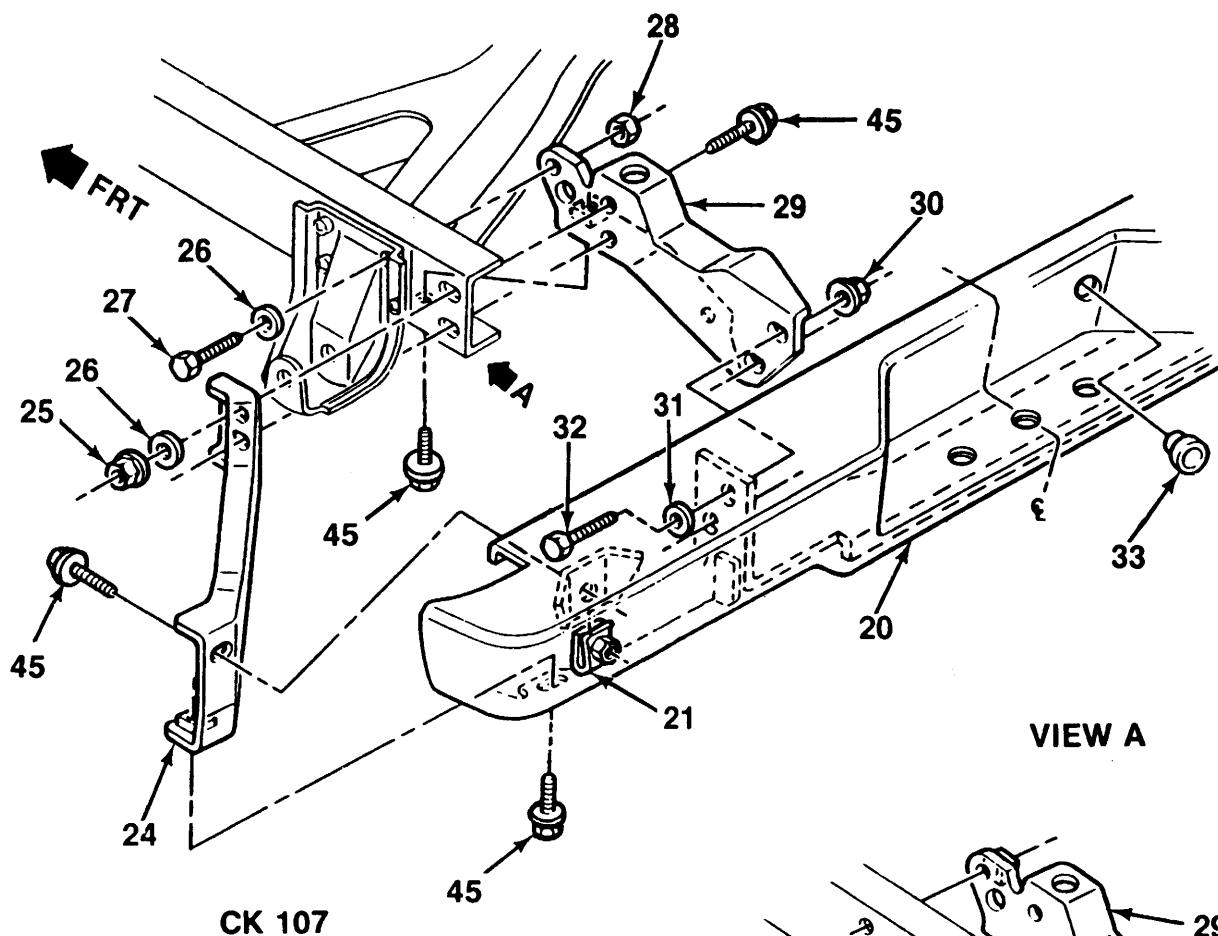


Install or Connect (Figures 9, 10 and 11)

NOTICE: For steps 2, 4, and 5, refer to "Notice" on page 2A-1.

1. Braces and brackets to the frame.
2. Brace and bracket bolts, washers and nuts.

- Be sure the harness is in place, if used.



- 20. Rear Bumper
- 21. Nut
- 22. Bolt
- 23. Washer
- 24. Brace
- 25. Nut
- 26. Washer
- 27. Bolt, Bracket and Brace
- 28. Nut (Except CK 109 & 200)
- 29. Bracket
- 30. Nut
- 31. Washer
- 32. Bolt, Bracket
- 33. Grommet
- 34. Rear Wiring Harness
- 45. Bolt Assembly

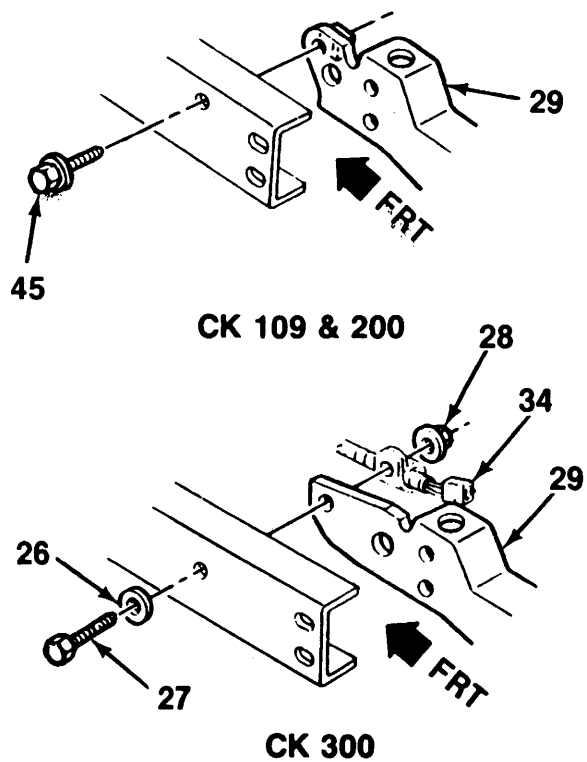
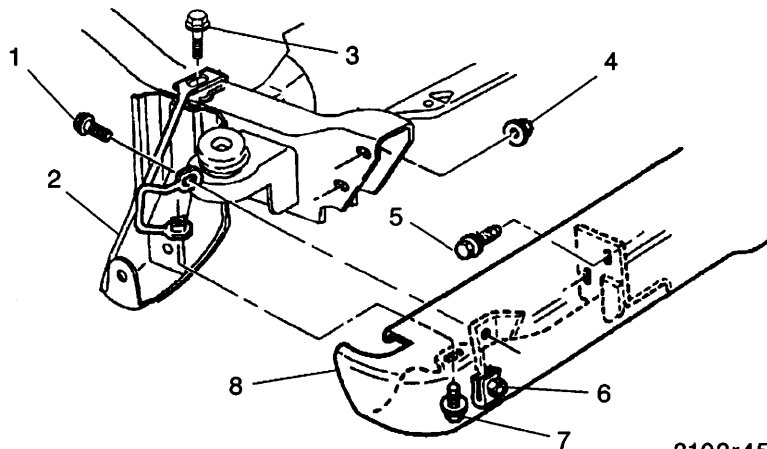


Figure 9—Rear Step Bumper

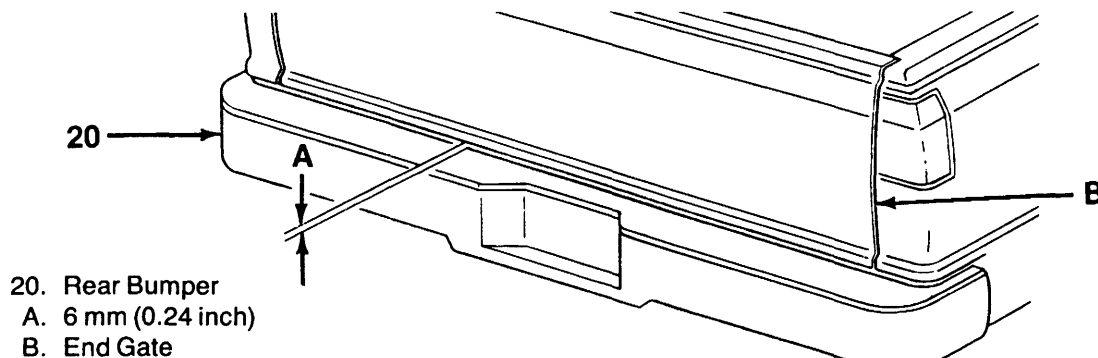
2A-12 FRAME AND BUMPERS

1. BOLT, 90 N·m (66 LBS. FT.)
2. BRACE
3. BOLT, 90 N·m (66 LBS. FT.)
4. NUT
5. BOLT, 90 N·m (66 LBS. FT.)
6. NUT
7. BOLT, 90 N·m (66 LBS. FT.)
8. BUMPER



3102r4505

Figure 10—Rear Bumper



F6576

Figure 11—Rear Bumper Alignment



Tighten

- Brace and bracket bolts to to 90 N·m (66 lbs. ft.).
 - Front bracket nut to 47 N·m (35 lbs. ft.).
3. Bumper to the vehicle.
 4. Bracket to the bumper bolts, washers and nuts.
 - Align the bumper (figure 8).



Tighten

- Bracket to the bumper bolts to 90 N·m (66 lbs. ft.).
5. Brace to bumper bolts, and nuts.



Tighten

- Brace to the bumper bolts to 90 N·m (66 lbs. ft.).
6. License plate lamp harness. Refer to SECTION 8B.

HITCH PLATFORM AND LICENSE PLATE BRACKET REPLACEMENT



Remove or Disconnect (Figures 12 and 13)

1. Bracket plate to hitch platform bolts and nuts (figure 12).
2. License plate bracket assembly from hitch platform.
3. Bolts, washers, and nuts from the hitch platform and frame rail.
4. Hitch platform from the vehicle.



Install or Connect (Figures 12 and 13)

NOTICE: For steps 2 and 4, refer to "Notice" on page 2A-1.

1. Hitch platform to the vehicle.
2. Hitch bolts and washers through the frame rails with nuts.



Tighten

- Hitch to the frame bolts to 100 N·m (74 lbs. ft.).

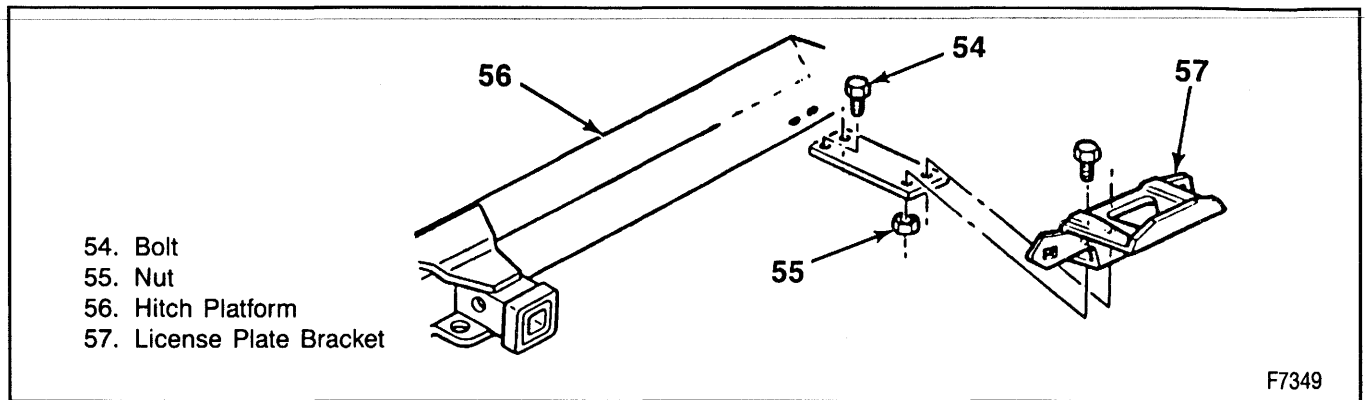


Figure 12—Hitch Platform License Plate Bracket

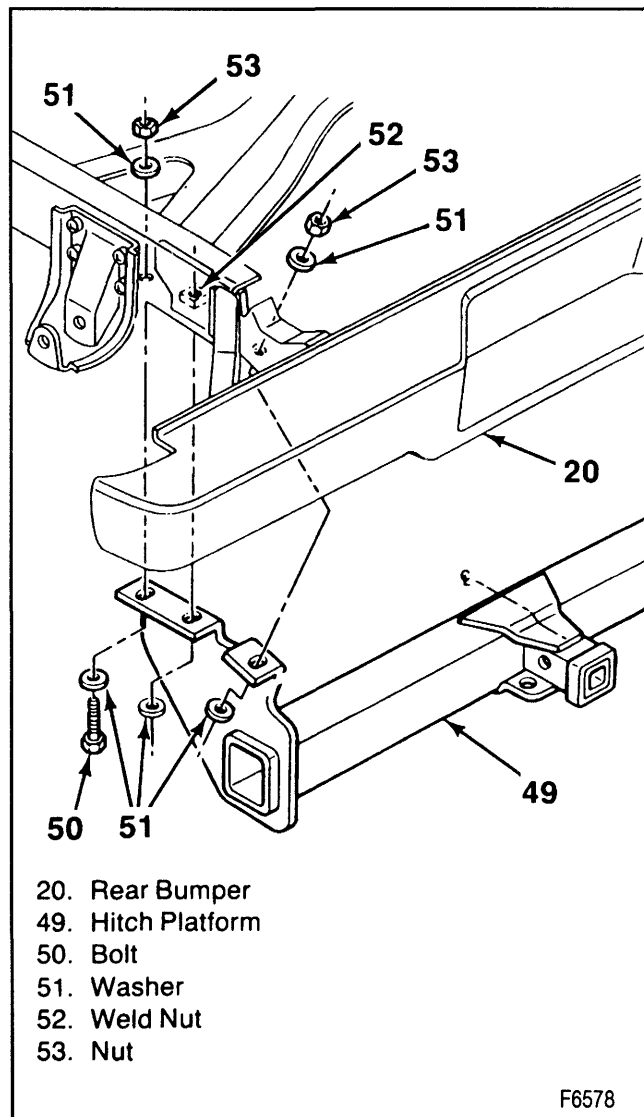


Figure 13—Weight Distribution Hitch Platform

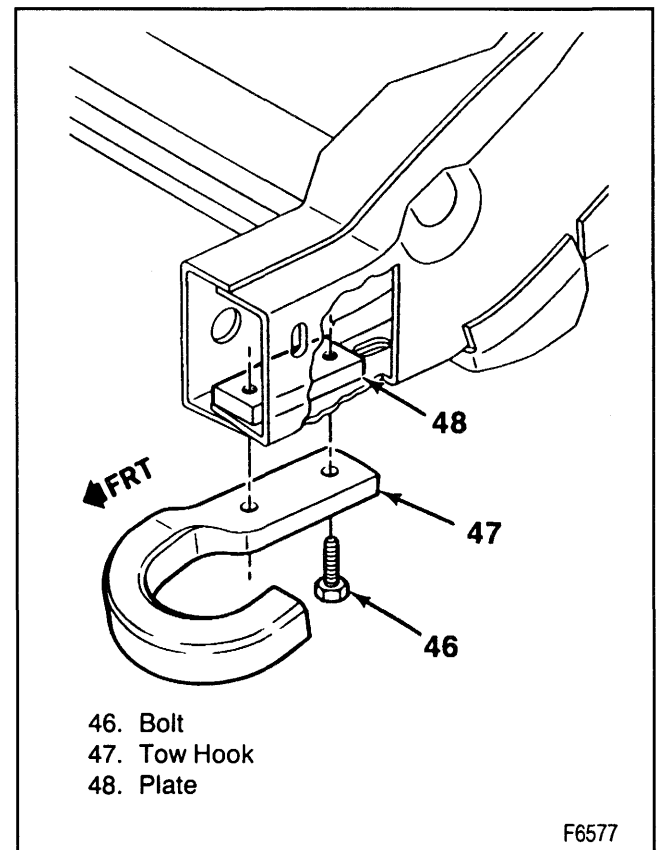


Figure 14—Tow Hooks

3. License plate bracket assembly to the hitch platform.
4. Bolts and nuts.

TOW HOOKS

←→ Remove or Disconnect (Figure 14)

1. Tow hook bolts from the frame rail.
2. Tow hook and plate from the vehicle.

→→ Install or Connect (Figure 14)

1. Tow hook and plate to the frame rail.

2A-14 FRAME AND BUMPERS

NOTICE: Refer to "Notice" on page 2A-1.



2. Frame rail to the tow hook bolts.
- Frame to the tow hook bolts to 60 N.m (44 lbs. ft.).

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Lbs. Ft.	Lbs. In.
Air Deflector to Bumper Bolts.....	10	—	89
Bumper Filler Panel to Radiator Support Screws	1.9	—	17
Bumper Guard to Bumper Nuts.....	25	18	—
Bumper Side Filler Panel to Fender Screws	1.9	—	17
Front Bumper to Brace Bolts.....	112	83	—
Front Bumper to Bracket Bolts.....	112	83	—
License Plate Bracket to Front Bumper Bolts	12.5	—	111
Platform Hitch to Frame Rail Bolts	100	74	—
Rear Bumper Brace to Bracket Bolts.....	90	66	—
Rear Bumper Bracket to Frame Nut.....	47	35	—
Rear Bumper to Brace Bolts	90	66	—
Rear Bumper to Bracket Bolts	90	66	—
Tow Hook to Frame Rail Bolts	60	44	—

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SECTION 2B

SHEET METAL

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing retainers that require it. If the above conditions are not followed, parts or system damage could result.

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ON-VEHICLE SERVICE

HOOD REPLACEMENT

↔ Remove or Disconnect (Figure 1)

- Raise and support the hood at the front and rear.
- Place protective coverings over the cowl and fenders.
- 1. Hood seals from over the hinges.
- 2. Bolt holding the hinge to the link assembly.
 - Lower the hood.
- 3. Outboard section of the cowl vent grille.
- 4. Bolt holding the hinge to the fender bracket.
- 5. Hood from the vehicle.

↔ Install or Connect (Figure 1)

NOTICE: For steps 2 and 4, refer to "Notice" on page 2B-1.

1. Hood to the vehicle.

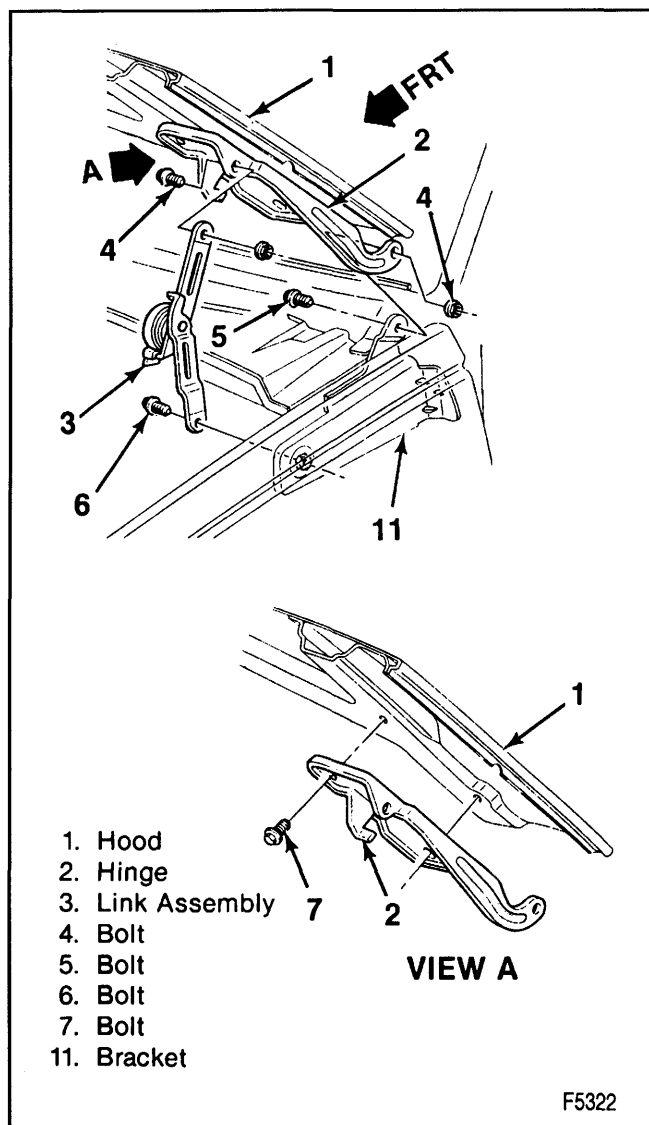


Figure 1—Hood Hinge Components

2. Bolt holding the hinge to the fender bracket.

⌚ Tighten

- Hood to fender bolt to 25 N.m (18 lbs. ft.).
- 3. Outboard section of the cowl vent grille.
 - Raise the hood.
- 4. Bolt holding the hinge to the link assembly.

⌚ Tighten

- Link to hinge bolt to 25 N.m (18 lbs. ft.).
- 5. Hood seals over the hinges.
 - Lower the hood.

HOOD INSULATOR REPLACEMENT

↔ Remove or Disconnect (Figure 2)

Tool Required:

J 38778 Door Trim Pad and Garnish Clip Remover.

1. Insulator to hood retainers using J 38778.
2. Insulator from the hood.

↔ Install or Connect (Figure 2)

1. Insulator to the hood.
2. Insulator to hood retainers.

HOOD HINGE REPLACEMENT

↔ Remove or Disconnect (Figure 1)

1. Outboard section of the cowl vent grille.
2. Hinge to fender bracket bolt.
 - Raise and support the hood at the front and rear.
3. Link assembly to hinge bolt.
4. Hinge to hood bolts.
5. Hinge from the hood.

↔ Install or Connect (Figure 1)

NOTICE: For steps 1, 2, and 3, refer to "Notice" on page 2B-1.

1. Hinge to the hood with bolts.

⌚ Tighten

- Hinge to the hood bolts to 25 N.m (18 lbs. ft.).
- 2. Link assembly to hinge bolt.

⌚ Tighten

- Link to the hinge bolt to 25 N.m (18 lbs. ft.).
- Lower the hood.
- 3. Hinge to fender bracket bolts.

⌚ Tighten

- Hinge to the fender bolts to 25 N.m (18 lbs. ft.).
- 4. Outboard section of the cowl vent grille.

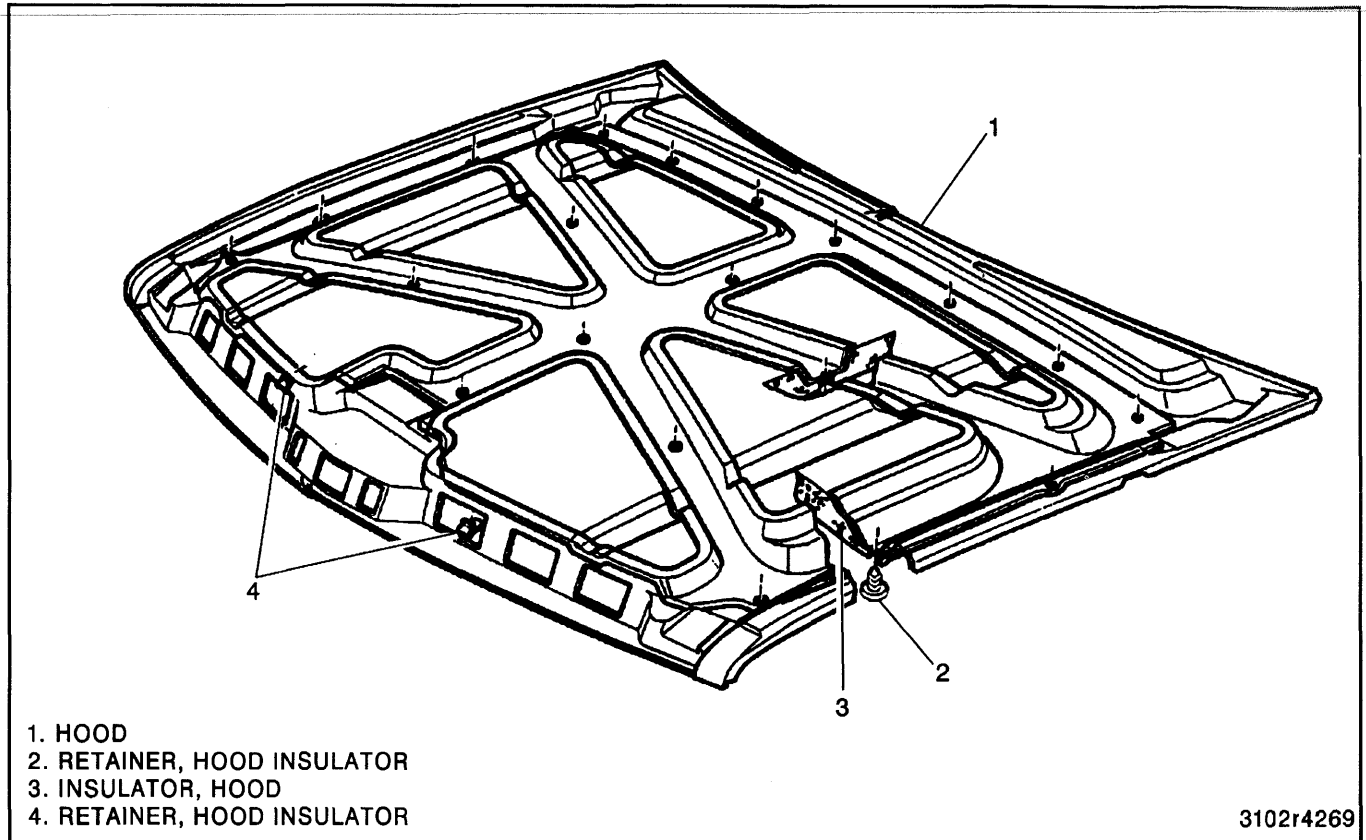


Figure 2—Hood Insulator

LINK ASSEMBLY REPLACEMENT

↔ Remove or Disconnect (Figure 1)

- Raise and support the front of the hood.

1. Link assembly to hood bolts.
2. Link assembly to fender bolts.
3. Link assembly from the vehicle.

→ Install or Connect (Figure 1)

NOTICE: For steps 2 and 3, refer to "Notice" on page 2B-1.

1. Link assembly to the vehicle.
2. Link assembly to fender bolts.

⌚ Tighten

- Link assembly to fender bolts to 25 N.m (18 lbs. ft.).

3. Link assembly to hood bolts.

⌚ Tighten

- Link assembly to hood bolts to 25 N.m (18 lbs. ft.).

PRIMARY HOOD LATCH REPLACEMENT

↔ Remove or Disconnect (Figure 3)

- Raise the hood.

1. Hood latch release cable from the latch. Refer to "Hood Release Cable Replacement."
2. Bracket to hood latch bolts.
3. Hood latch from the vehicle.
4. Bracket to radiator support bolts.

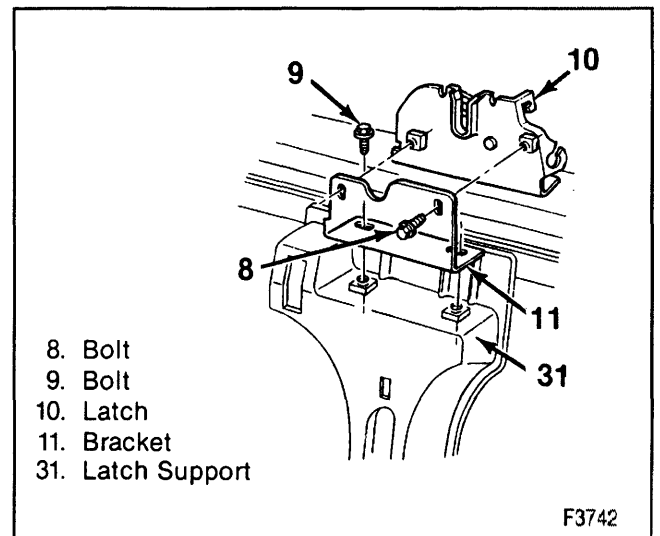


Figure 3—Primary Hood Latch Components

2B-4 SHEET METAL

5. Bracket from the vehicle.



Adjust

- Front hood bumpers, so that the top of the hood is flush with the fenders.



Install or Connect (Figure 3)

NOTICE: For steps 2 and 4, refer to "Notice" on page 2B-1.

1. Bracket to the radiator support.
2. Bracket to support bolts loosely.
3. Primary hood latch to the bracket.
4. Latch to bracket bolts loosely.
5. Hood latch release cable to the latch.



Adjust

1. Hood latch bracket left and right until the striker in the hood easily engages the primary latch.
 - Raise the hood.



Tighten

- Bracket to radiator support bolts to 25 N·m (18 lbs. ft.).
2. Hood latch height so that when the hood is closed, the hood is held securely against the front hood bumpers. Mark this height.
 - Raise the hood.



Tighten

- Bracket to hood latch bolts to 25 N·m (18 lbs. ft.).

SECONDARY HOOD LATCH AND SPRING REPLACEMENT



Remove or Disconnect (Figure 4)

- Mark the position of the secondary hood latch on the hood.
1. Secondary hood latch to hood bolts.
 2. Secondary hood latch from the vehicle.
 3. Spring from the hood.
 - Twist the spring from the reinforcement.



Install or Connect (Figure 4)

1. Spring to the hood.
 - Twist the spring into the reinforcement.
2. Secondary hood latch to the vehicle.

NOTICE: Refer to "Notice" on page 2B-1.

3. Secondary hood latch to hood bolts.



Tighten

- Latch to hood bolts to 25 N·m (18 lbs. ft.).

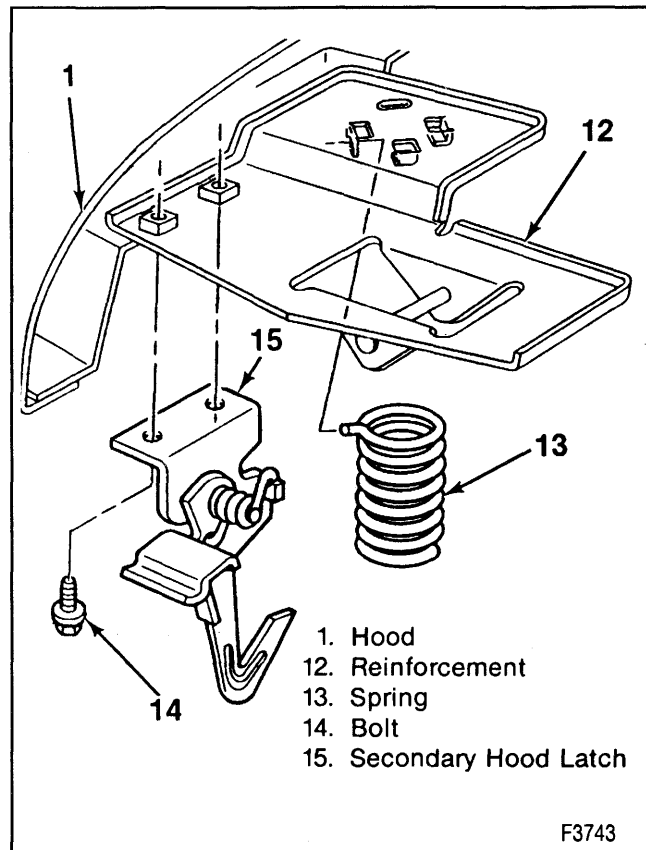


Figure 4—Secondary Hood Latch Components

HOOD RELEASE CABLE REPLACEMENT



Remove or Disconnect (Figure 5)

- If the cable is broken, release the hood by pressing the primary latch tab on the left side of the lock assembly. Use a rod to press the tab.
 - Raise the hood.
1. Cable from the primary latch.
 - Insert a screwdriver into the clip, and lift the cable from the lock, then carefully pry the cable grommet from the lock flange.
 2. Two bolts from the upper left radiator grille.
 3. Cable from the radiator support and from the wheelhouse retaining clips.
 4. Two bolts from under the instrument panel inside the cab retaining the hood release handle.
 - Push the cable and grommet into the cab from the engine compartment.
 5. Cable from the vehicle.



Install or Connect (Figure 5)

1. Cable to the vehicle.
2. Cable from the driver's side of the cowl.
 - Push the cable and the grommet into the engine compartment.
3. Two bolts holding the hood release handle to the bottom of the instrument panel.
 - Seat the grommet.

4. Cable through the retaining clips and the radiator support.
5. Two bolts into the upper left radiator grille.
6. Cable to the primary latch.

COWL VENT GRILLE REPLACEMENT

↔ Remove or Disconnect (Figure 6)

1. Wiper arms. Refer to SECTION 8E.
2. Cowl weatherstrip.
3. Cowl vent grille panel screws.
4. Windshield washer hoses and nozzles.
5. Three cowl vent grille panels from the vehicle.

→ Install or Connect (Figure 6)

1. Windshield washer hoses and nozzles to the cowl vent grille.
2. Three cowl vent grille panels to the vehicle.
3. Cowl vent grille panel screws.
 - Be sure the nuts below the center panel are in place with the square nut second from the right.
4. Cowl weatherstrip.
5. Wiper arms. Refer to SECTION 8E.

RADIATOR GRILLE REPLACEMENT

↔ Remove or Disconnect (Figure 7)

1. Screws from the parking lamps and side markers.
2. Parking lamps and side markers.
3. Bolts holding the grille to the vehicle.
 - Screw holding the grille to the latch support.
 - Screw holding the grille bracket to the latch support.
 - Screws holding the grille to the radiator support.
4. Grille from the filler panel and the vehicle.

→ Install or Connect (Figure 7)

1. Grille to the vehicle and the filler panel.

NOTICE: Refer to "Notice" on page 2B-1.

2. Grille and filler panel to the vehicle with bolts.
 - Screws holding the grille to the radiator support.
 - Screw holding the grille bracket to the latch support.
 - Screw holding the grille to the latch support.

⌚ Tighten

- Grille to the vehicle screws to 1.5 N·m (13 lbs. in.).
3. Parking lamps and side markers with screws.

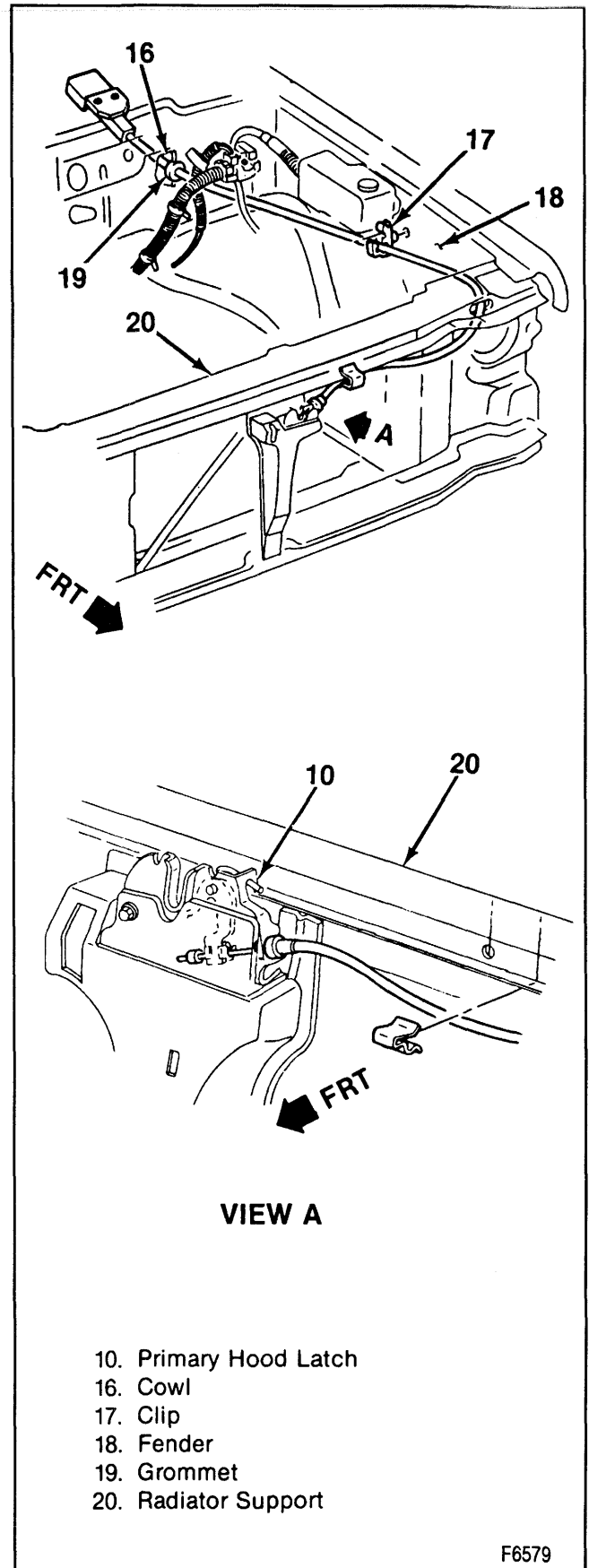


Figure 5—Hood Release Cable

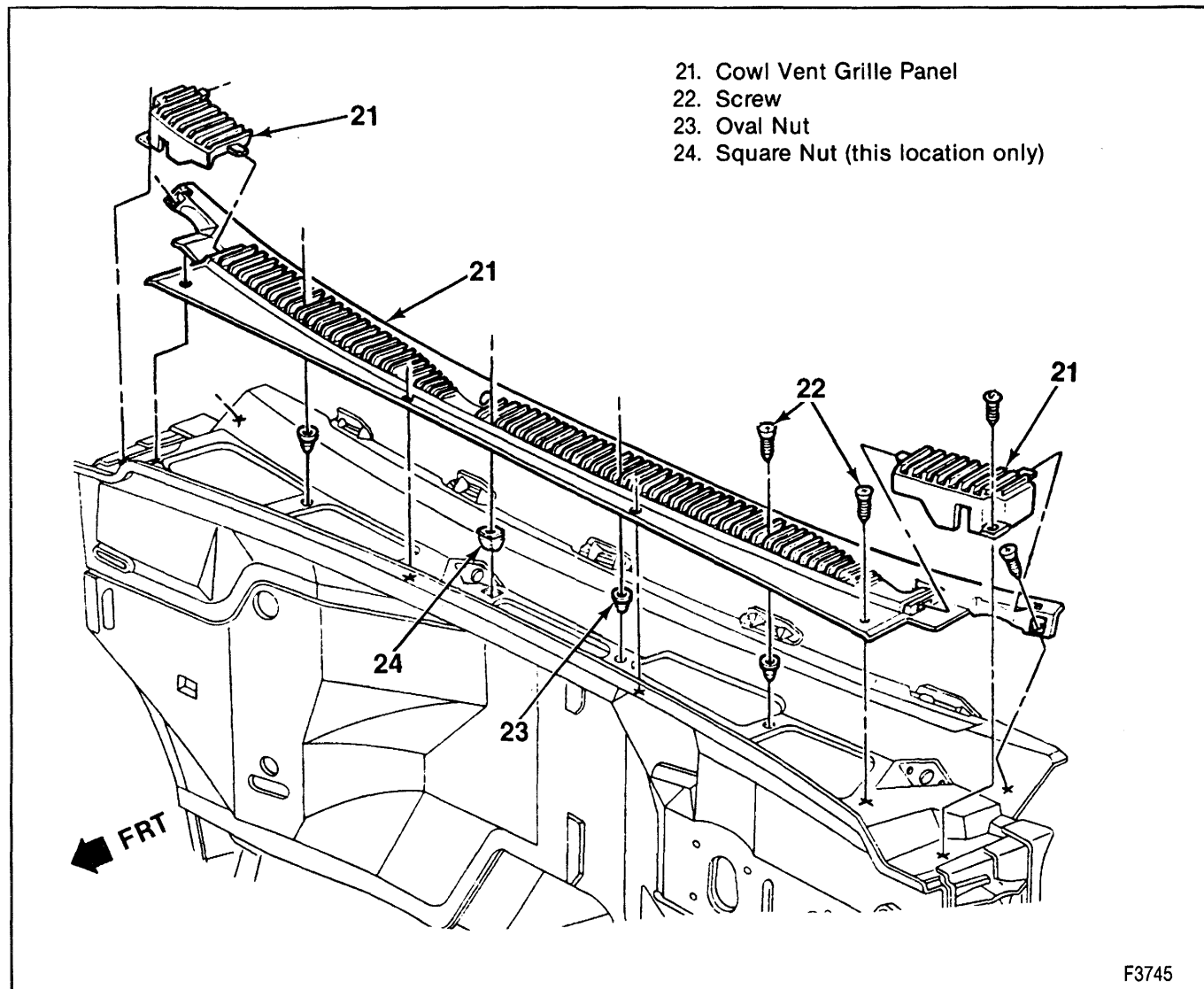


Figure 6—Cowl Vent Grille Components

FENDER REPLACEMENT

RIGHT FENDER

↔ Remove or Disconnect (Figures 8, 9, and 10)

1. Negative battery cable. Refer to SECTION 0A.
2. Hood link assembly from the fender. Refer to "Link Assembly Replacement."
3. Hinge to fender bolt.
4. Hood. Refer to "Hood Replacement."
5. Radio antenna from the fender.
6. Wiring inside the fender.
7. Air cleaner hose from the fender in the engine compartment.
8. Battery and battery tray.
9. Forward air inlet duct assembly from the fender.
10. Wiring from the clips.
11. Underhood lamp (if present).
12. Bolt from inside the engine compartment.
13. Bolts holding the fender to the wheelhouse (figure 8).

14. Bolt by reaching up behind the wheelhouse (figure 9).
15. Bolt holding the fender to the cab assembly (figure 10).

• Open the door.

16. Bolts holding the fender to the door hinges (figure 9).
17. Bolt holding the fender to the radiator support.
18. Fender from the vehicle.

↔ Install or Connect (Figure 8, 9, and 10)

NOTICE: For steps 2 through 5, 9, and 16, refer to "Notice" on page 2B-1.

1. Fender to the vehicle.
2. Bolt from inside the engine compartment (figure 9).



Tighten

- Bolt to 25 N·m (18 lbs. ft.).

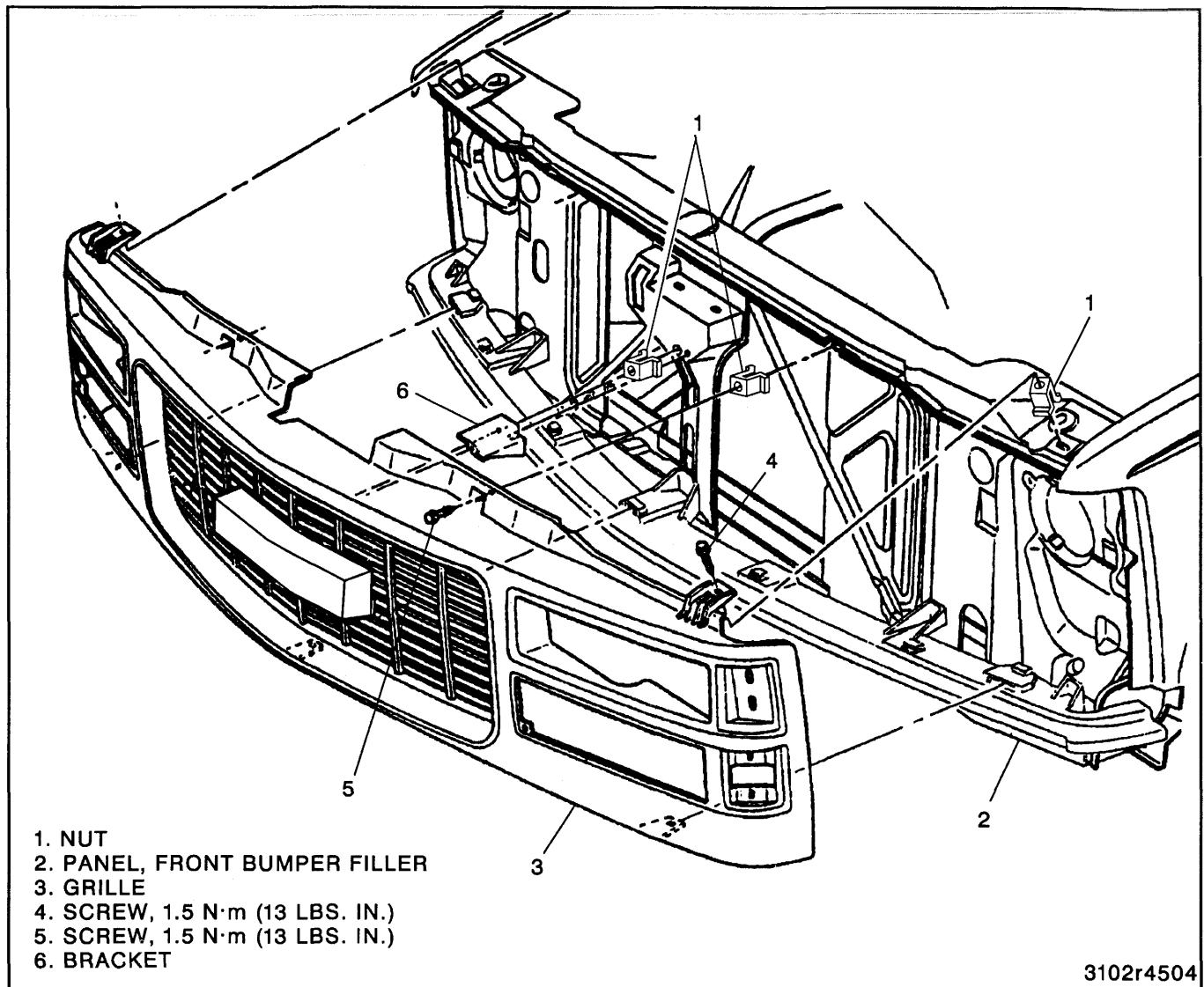


Figure 7—Radiator Grille Components

3. Bolt to the radiator support.



Tighten

- Fender to radiator support bolt to 25 N·m (18 lbs. ft.).

4. Bolts and nuts holding the fender to the door hinges.



Tighten

- Fender to door hinge bolts to 25 N·m (18 lbs. ft.).

5. Bolt and nut from the fender to the cab assembly (figure 10).



Tighten

- Fender to cab bolts to 25 N·m (18 lbs. ft.).

6. Bolt by reaching up behind the wheelhouse (figure 9).

7. Bolts through the wheelhouse to the fender (figure 8).

8. Forward air inlet duct assembly to the front section of the fender in the engine compartment.

9. Battery tray and battery.



Tighten

- Tray bolts to 25 N·m (18 lbs. ft.).

10. Air cleaner hose to the fender.

11. Wiring inside the fender.

12. Radio antenna into the fender.

13. Wiring into clips.

14. Underhood lamp (if present).

15. Hood link assembly. Refer to "Link Assembly Replacement."

16. Hood hinge to the hood.



Tighten

- Hinge to hood bolts to 25 N·m (18 lbs. ft.).

17. Hood to the vehicle. Refer to "Hood Replacement."

- Check the fender for proper clearance. Refer to "Sheet Metal Adjustments."

18. Negative battery cable.

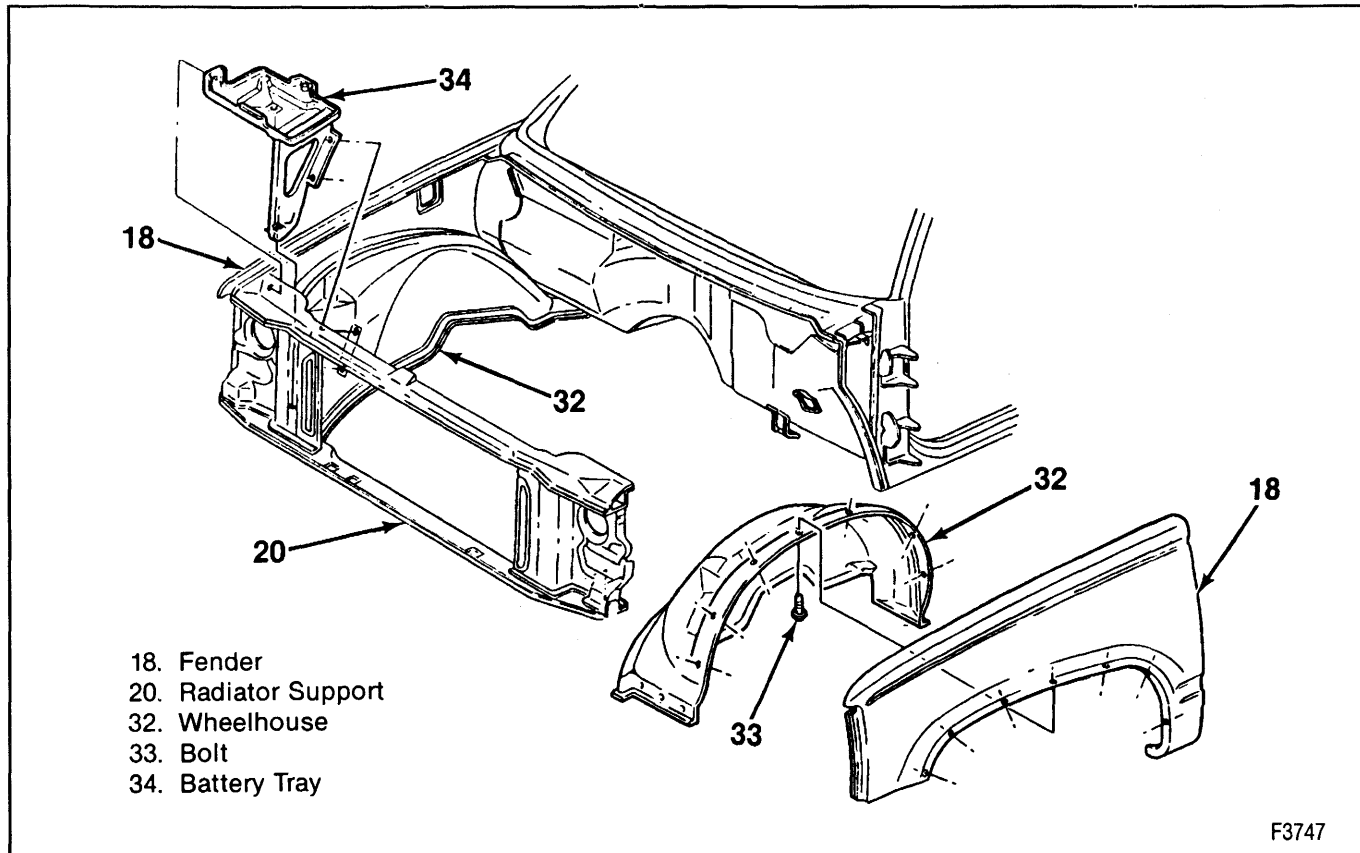


Figure 8—Fender and Wheelhouse Assemblies

LEFT FENDER

↔ Remove or Disconnect (Figures 1, 8, 9, and 10)

1. Negative battery cable. Refer to SECTION 0A.
2. Link assembly from the fender. Refer to "Link Assembly Replacement."
3. Hinge to fender bolt.
4. Hood. Refer to "Hood Replacement."
5. Battery and battery tray (on diesel models).
6. Windshield washer reservoir.
7. Hood release cable from the clip on the fender.
8. Wiring harness from the clips.
9. Relay bracket.
10. Bolts holding the fender to the wheelhouse (figure 8).
11. Bolt by reaching up behind the wheelhouse (figure 9).
12. Bolt holding the fender to the cab assembly (figure 10).
 - Open the door.
13. Bolts holding the fender to the door hinges (figure 9).
14. Bolt holding the fender to the radiator support.
15. Bolt from inside the engine compartment.
16. Fender from the vehicle.

→ Install or Connect (Figures 1, 8, 9, and 10)

NOTICE: For steps 2 through 5, and 15, refer to "Notice" on page 2B-1.

1. Fender to the vehicle.
2. Bolt from inside the engine compartment (figure 9).

⌚ Tighten

- Bolt to 25 N.m (18 lbs. ft.).

3. Bolt to the radiator support.

⌚ Tighten

- Fender to the radiator support bolt to 25 N.m (18 lbs. ft.).
- Open the door.

4. Bolts and nuts holding the fender to the door hinges.

⌚ Tighten

- Fender to door hinge bolts to 25 N.m (18 lbs. ft.).

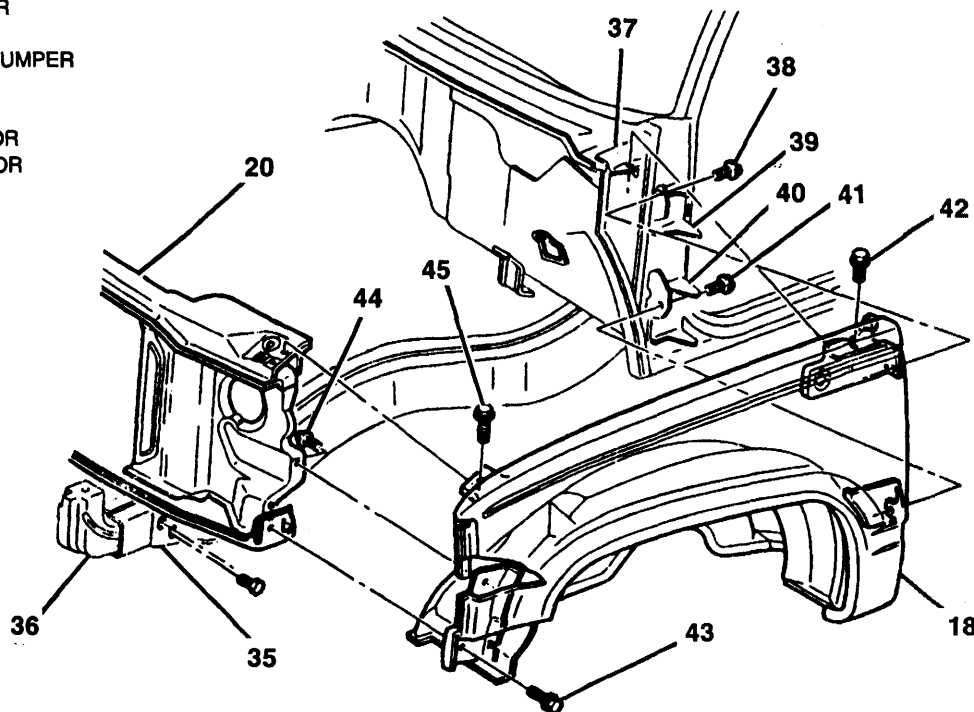
5. Bolt and nut from the fender to the cab assembly (figure 10).

⌚ Tighten

- Fender to cab bolt to 25 N.m (18 lbs. ft.).

6. Bolt by reaching up behind the wheelhouse (figure 9).
7. Bolts through the wheelhouse to the fender (figure 8).
8. Wiring harness into the clip on the fender.
9. Hood release cable into the clips.
10. Windshield washer reservoir.

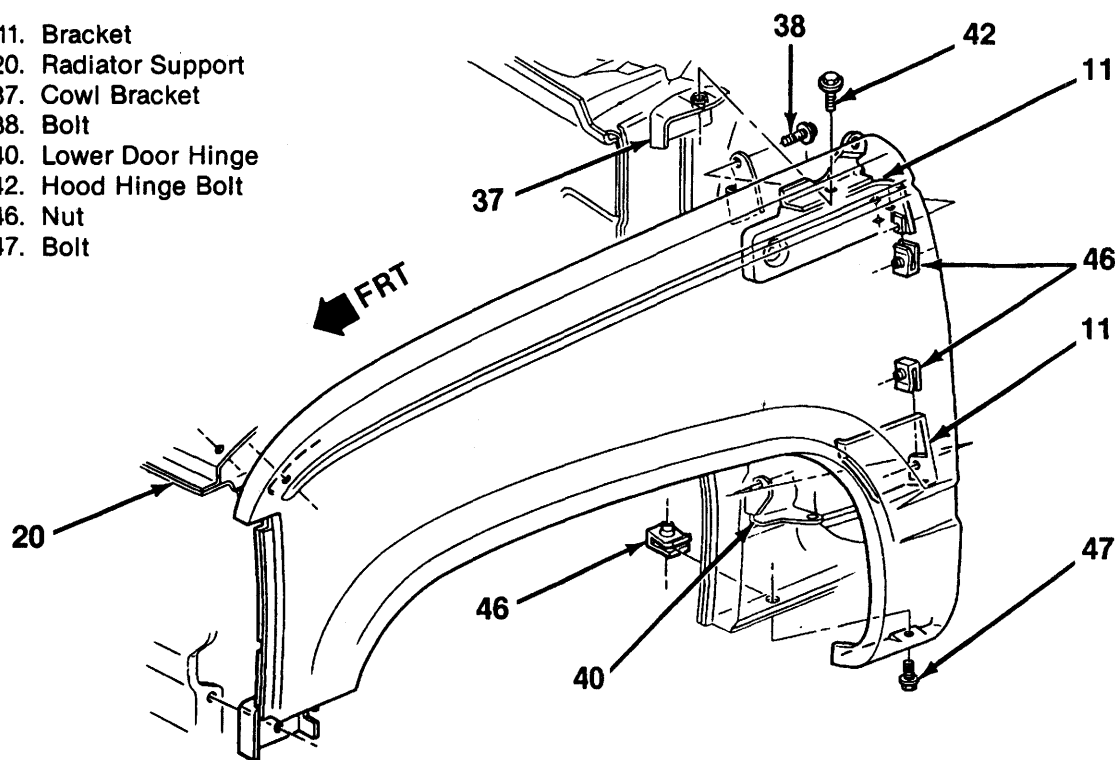
- 18. FENDER
- 20. SUPPORT, RADIATOR
- 35. FRAME
- 36. BRACKET, FRONT BUMPER
- 37. BRACKET, COWL
- 38. BOLT
- 39. HINGE, UPPER DOOR
- 40. HINGE, LOWER DOOR
- 41. BOLT
- 42. BOLT, HINGE HOOD
- 43. BOLT
- 44. BOLT
- 45. BOLT



F3748

Figure 9—Fender to Vehicle Attachment

- 11. Bracket
- 20. Radiator Support
- 37. Cowl Bracket
- 38. Bolt
- 40. Lower Door Hinge
- 42. Hood Hinge Bolt
- 46. Nut
- 47. Bolt



F3749

Figure 10—Fender Assembly

2B-10 SHEET METAL

11. Battery tray (on diesel models).
12. Battery (diesels).
13. Relay bracket.
14. Link assembly.
15. Hood hinge to the vehicle.



Tighten

- Hood hinge to vehicle bolts to 25 N.m (18 lbs. ft.).

16. Hood to the vehicle.
17. Negative battery cable.

STEPSIDE FENDER REPLACEMENT



Remove or Disconnect (Figures 11 through 14)

1. Pads from fender steps (figure 11).
2. Fender to brace screws (figure 12).
3. Brace to support bolts.
4. Fender to support bolts (figure 13).

5. Taillamp side panel screws.
6. Fender to bracket screws.
7. Fender to side panel screws.
8. Fender.
9. Fender supports and bolts (figure 14).



Install or Connect (Figures 11 through 14)

NOTICE: For steps 1 through 7, refer to "Notice" on page 2B-1.

1. Fender supports and screws.



Tighten

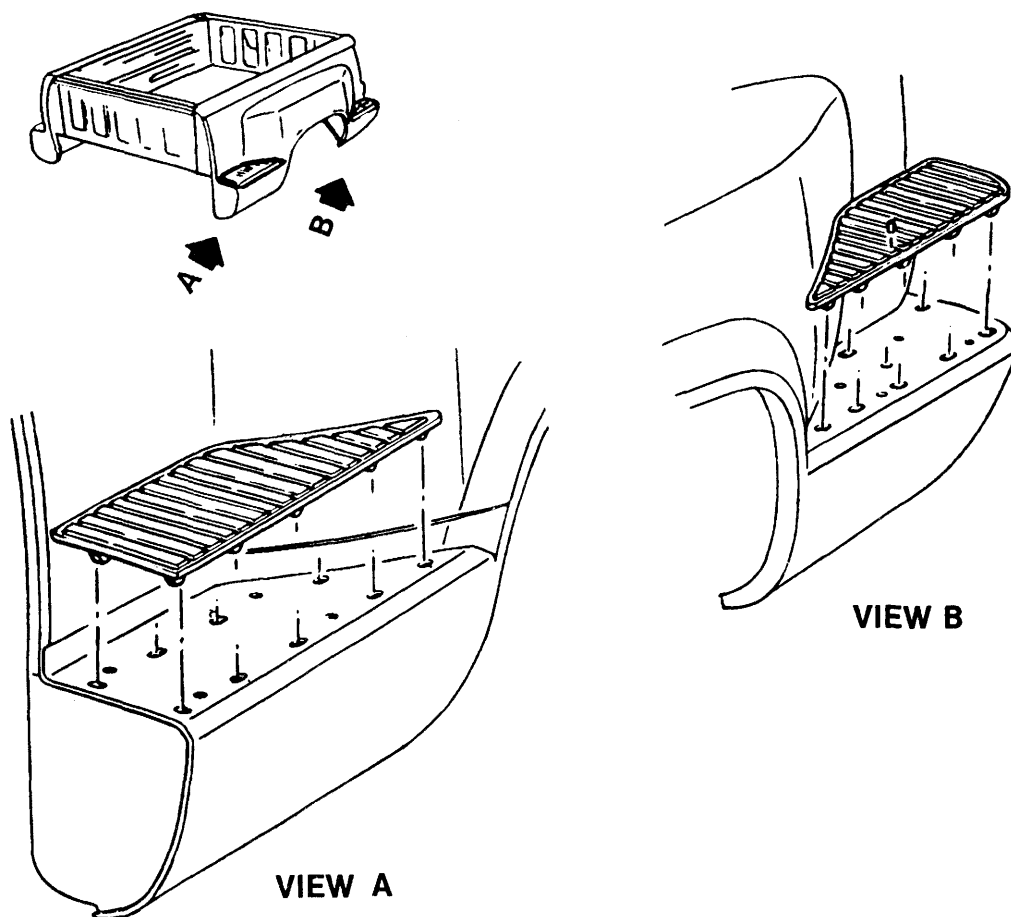
- Support screws to 17 N.m (13 lbs. ft.).

2. Fender to the pickup box with screws.



Tighten

- Fender to pickup box screws to 17 N.m (13 lbs. ft.).



F6581

Figure 11—Step Pads

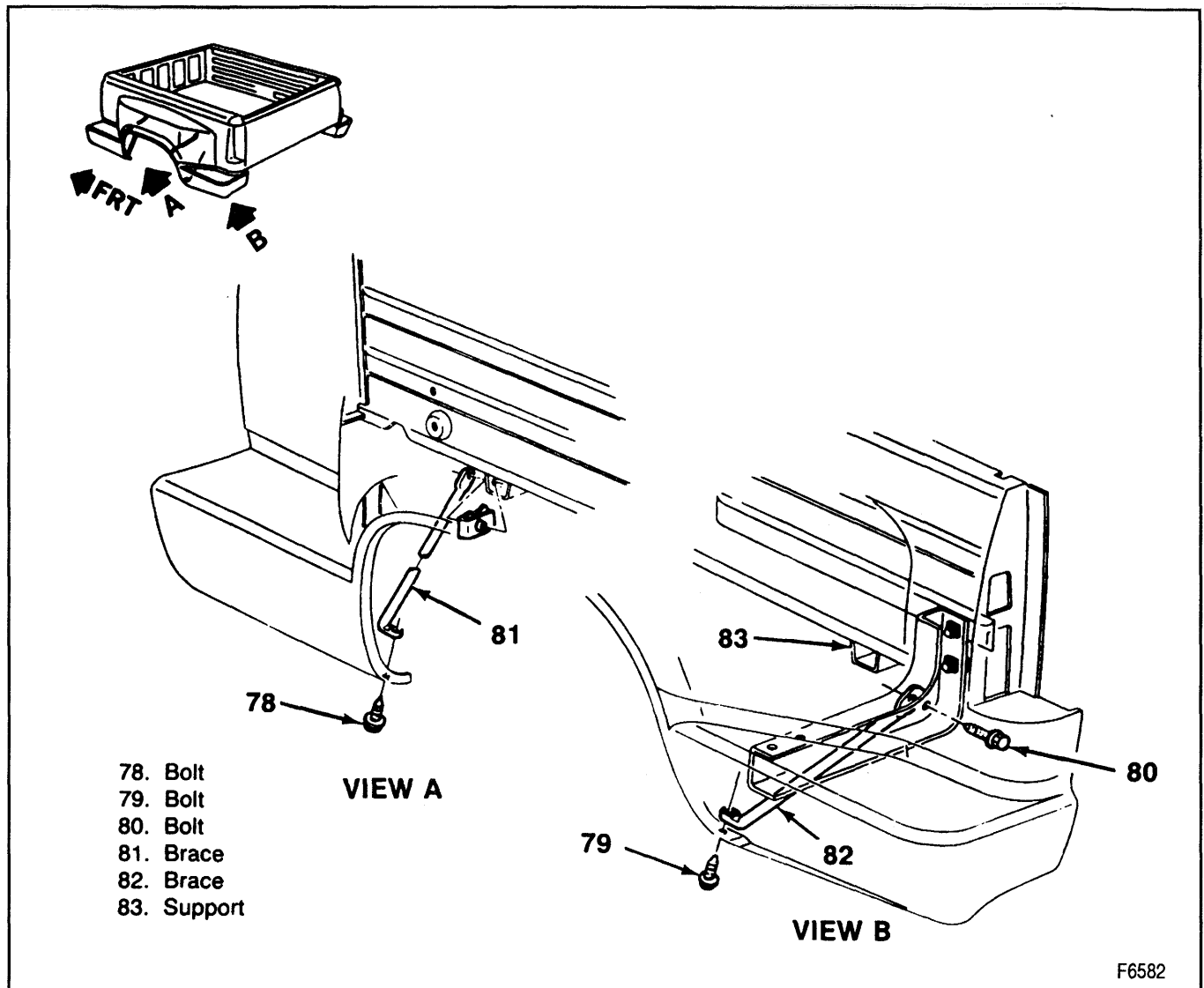


Figure 12—Fender Braces

3. Fender to side panel screws. Do not tighten screws until the lower mounting screws are installed.



Tighten

- Fender to the side panel screws to 17 N.m (13 lbs. ft.).

4. Fender to bracket screws.



Tighten

- Fender to the bracket screws to 17 N.m (13 lbs. ft.).

5. Side panel screws and taillamp.



Tighten

- Side panel screws to 17 N.m (13 lbs. ft.).

6. Fender to support screws.



Tighten

- Fender to support screws to 17 N.m (13 lbs. ft.).

7. Brace to support screws.



Tighten

- All other screws to 17 N.m (13 lbs. ft.).

8. Pads to the fender steps.

REAR FENDER REPLACEMENT (DUAL WHEEL)



Remove or Disconnect (Figure 15)

1. Wiring connector to the side marker.
2. Fender to side panel bolts.
3. Fender to brace bolts.
4. Wheelhouse filler panel and bolts.
5. Nuts from the fender studs.
6. Fender from the side panel.



Install or Connect (Figure 15)

NOTICE: For steps 1, 2 and 4, refer to "Notice" on page 2B-1.

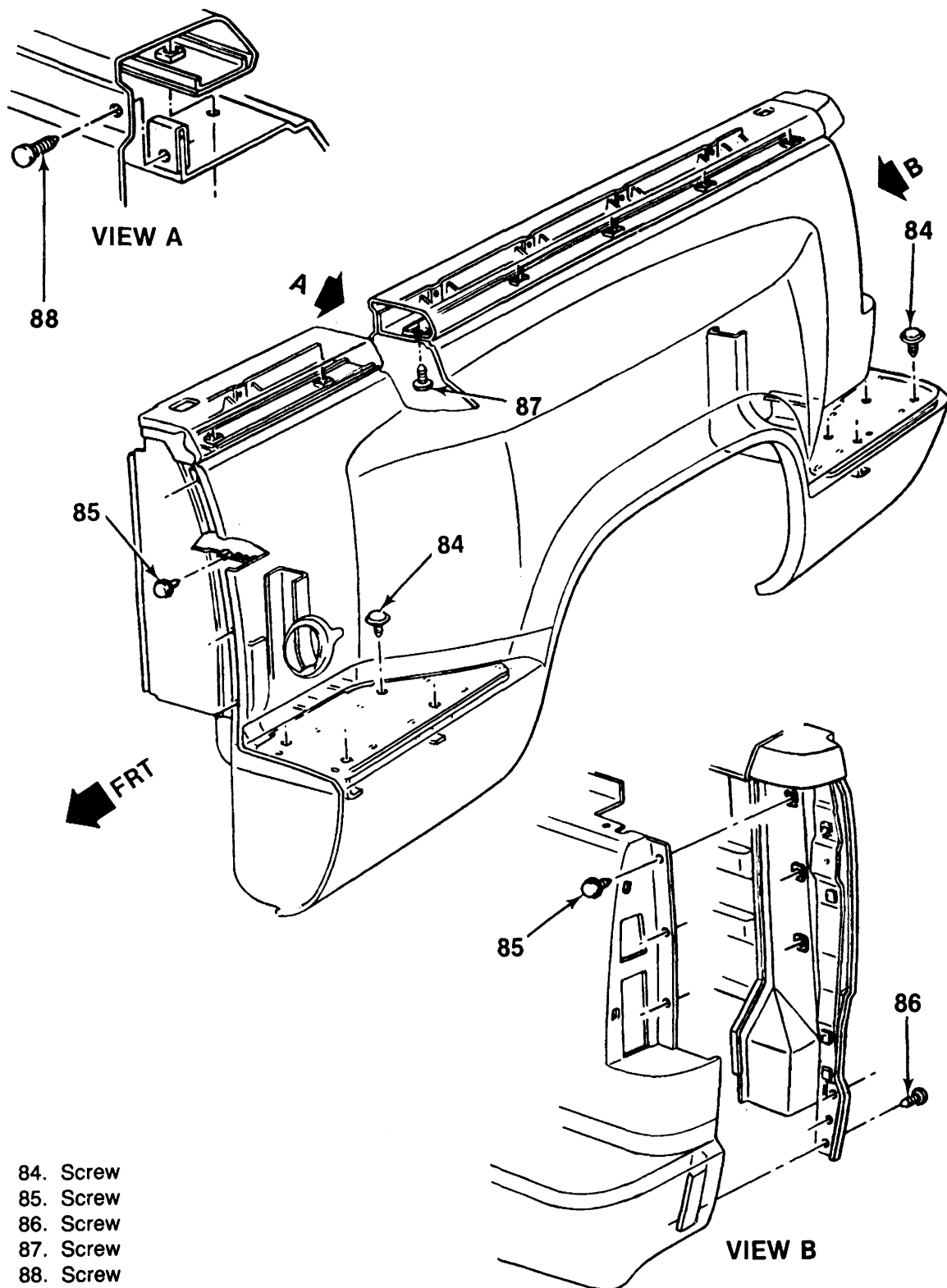


Figure 13—Stepside Fender

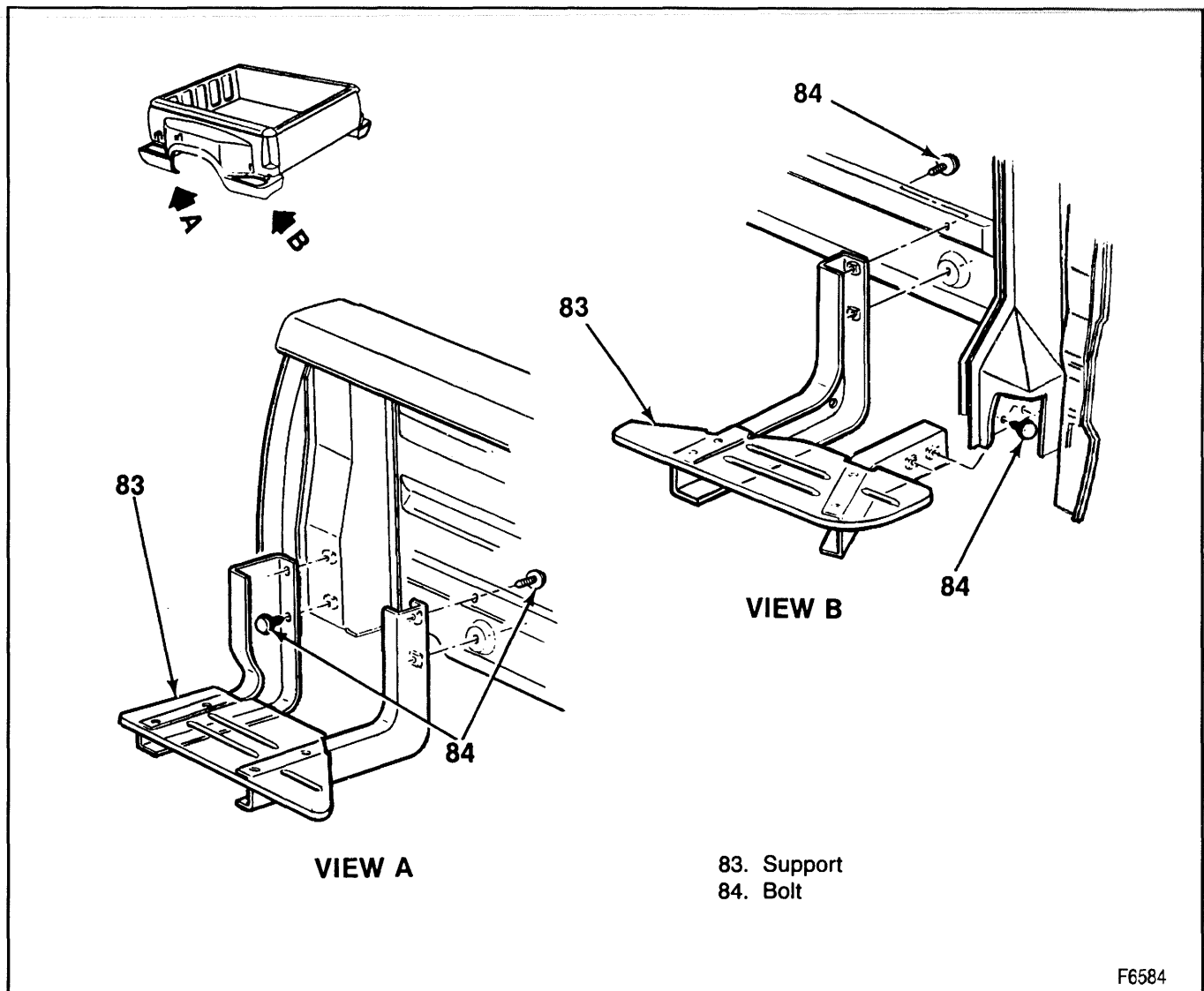


Figure 14—Fender Supports

F6584

1. Fender to the side panel with bolts.



Tighten

- Fender to the side panel bolts to 25 N.m (18 lbs. ft.).

2. Nuts to the fender studs.



Tighten

- Nuts to fender studs to 25 N.m (18 lbs. ft.).

3. Wheelhouse filler panel with bolts.

4. Fender to brace bolts.



Tighten

- Fender to the brace bolts to 25 N.m (18 lbs. ft.).

5. Wiring connector to the side marker.

WHEELHOUSE PANEL REPLACEMENT

RIGHT PANEL REPLACEMENT



Remove or Disconnect (Figures 16 and 17)

- Open the hood.

1. Battery cables. Refer to SECTION 0A.
2. Battery and battery tray.
3. Heater hoses from the clip on the wheelhouse.
4. Air cleaner hose bracket.
5. Air conditioning evaporator tube from the clip.
- Raise and support the vehicle.
6. Right front tire and wheel assembly.
7. Fender to wheelhouse bolts.
8. Two bolts holding the wheelhouse to the cowl mounting brackets (figure 17).
9. Three wheelhouse to radiator support bolts.
10. Wheelhouse panel from the vehicle.

- Tilt the panel out of the vehicle.

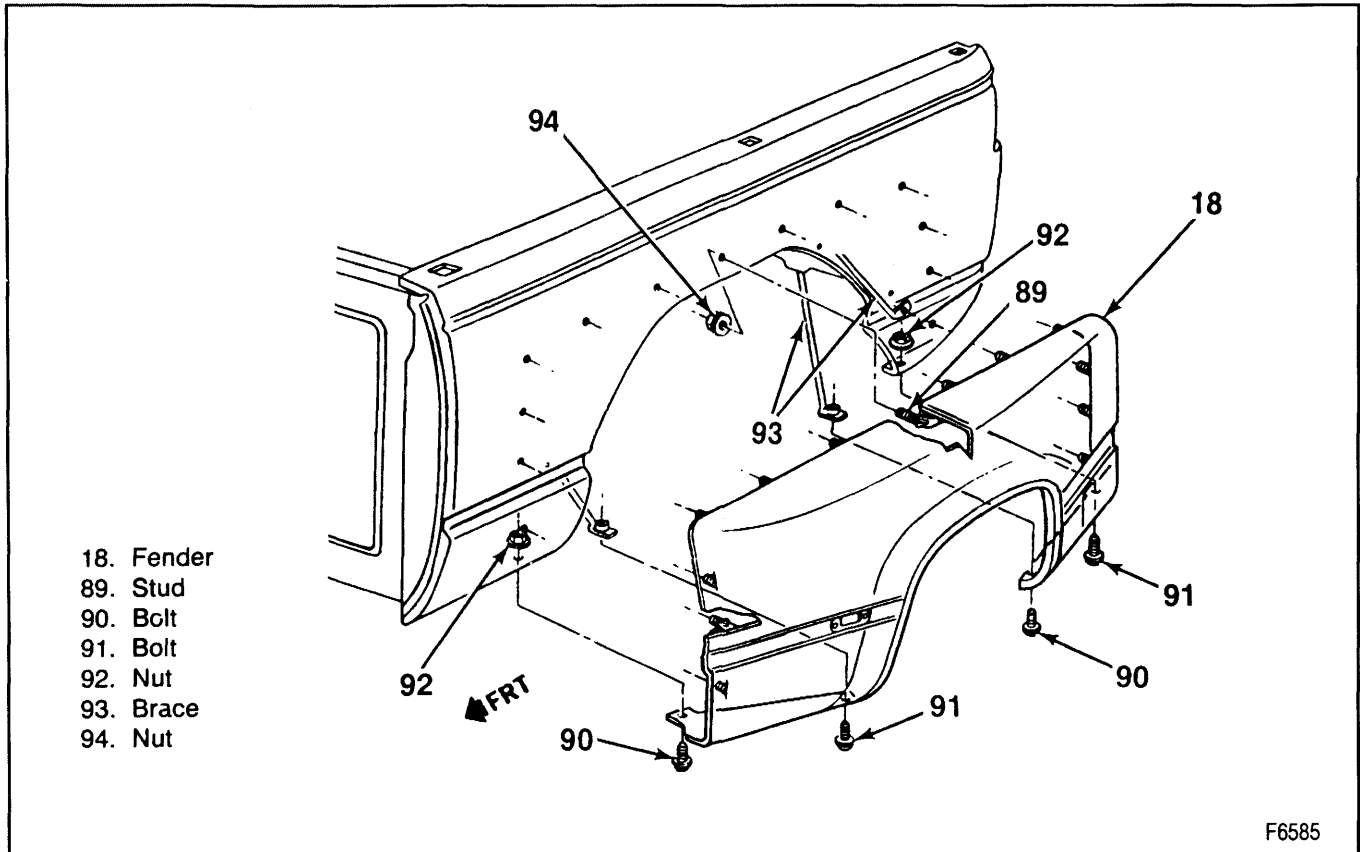


Figure 15—Rear Fender (Dual Wheel)

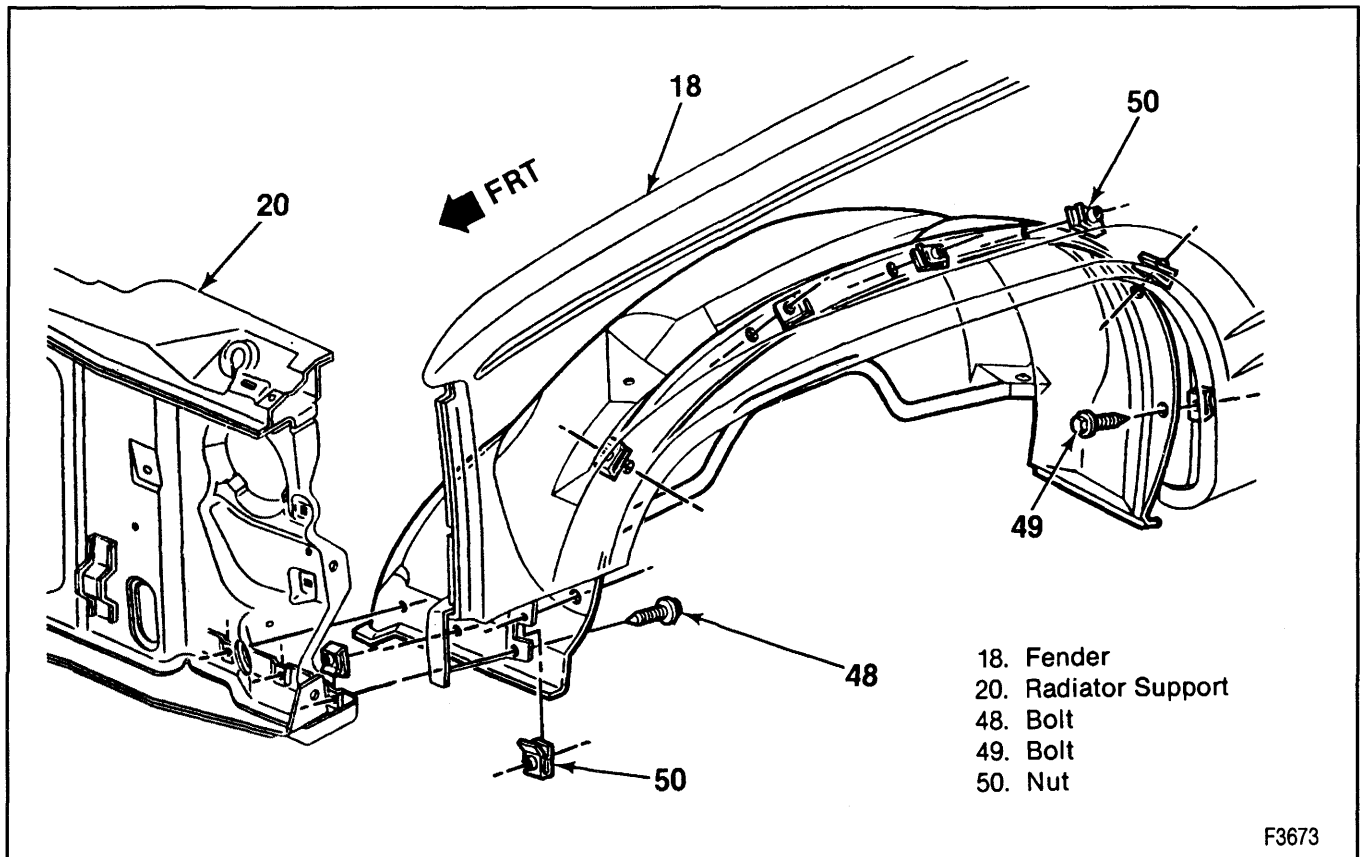


Figure 16—Wheelhouse Panel to Radiator Support Attachment

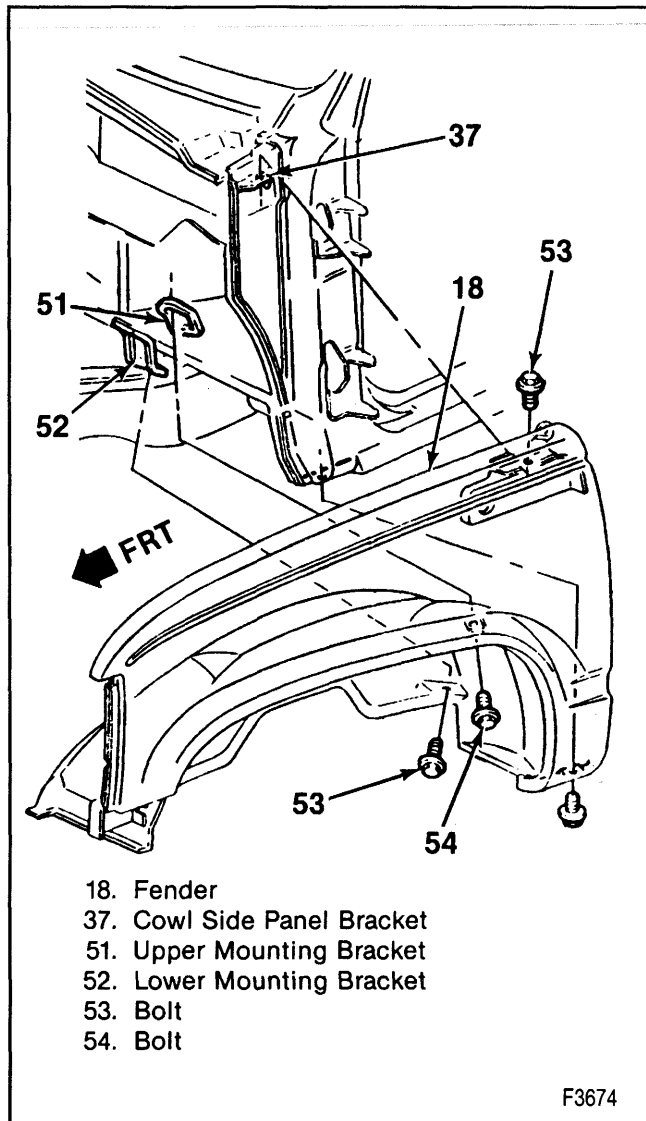


Figure 17—Wheelhouse Panel to Cowl Mounting

→→ Install or Connect (Figures 16 and 17)

NOTICE: For steps 2, 3, and 4, refer to "Notice" on page 2B-1.

1. Wheelhouse panel to the vehicle.
 - Tilt the panel into the vehicle.
2. Three wheelhouse to radiator support bolts and nuts.

⌚ Tighten

- Wheelhouse to radiator support bolts to 25 N.m (18 lbs. ft.).

3. Two wheelhouse to cowl mounting bracket bolts.

⌚ Tighten

- Wheelhouse to cowl bolts to 25 N.m (18 lbs. ft.).

4. Fender to wheelhouse bolts and nuts.

⌚ Tighten

- Fender to wheelhouse bolts to 25 N.m (18 lbs. ft.).
5. Right front wheel.
 - Lower the vehicle.
 6. Air conditioning evaporator tube into the clip.
 7. Air cleaner hose bracket to the wheelhouse.
 8. Heater hoses into the clip.
 9. Battery tray and battery.
 10. Battery cables.

LEFT PANEL REPLACEMENT

→→ Remove or Disconnect (Figures 16 and 17)

1. Battery cables (diesel models). Refer to SECTION 0A.
2. Battery and battery tray (diesel models).
 - Raise and support the vehicle.
3. Left front tire and wheel assembly.
4. Fender to wheelhouse bolts.
5. Two bolts holding the wheelhouse to the cowl mounting brackets.
6. Three wheelhouse to radiator support bolts.
7. Wheelhouse panel from the vehicle.
 - Tilt the panel out of the vehicle.

→→ Install or Connect (Figures 16 and 17)

NOTICE: For steps 2, 3, 4, and 6, refer to "Notice" on page 2B-1.

1. Wheelhouse panel to the vehicle.
 - Tilt the panel into the vehicle.
2. Three wheelhouse to radiator support bolts and nuts.

⌚ Tighten

- Wheelhouse to radiator support bolts to 25 N.m (18 lbs. ft.).
3. Two wheelhouse to cowl mounting bracket bolts.

⌚ Tighten

- Wheelhouse to cowl bolts to 25 N.m (18 lbs. ft.).
4. Fender to wheelhouse bolts and nuts.

⌚ Tighten

- Fender to wheelhouse bolts to 25 N.m (18 lbs. ft.).
5. Left front tire and wheel assembly.
 - Lower the vehicle.
 6. Battery and battery tray (diesel models).

⌚ Tighten

- Tray bolts to 25 N.m (18 lbs. ft.).
7. Battery cables (diesel models).
 - Close the hood.

FENDER WHEELHOUSE OPENING FLARES

FRONT FENDER

↔ Remove or Disconnect (Figure 18)

1. Fender. Refer to "Fender Replacement."
2. Flare to fender screws around the wheel opening.
3. Fender to flare nut at each end of the flare from inside the fender.
4. Flare.

↔ Install or Connect (Figure 18)

NOTICE: For steps 3 and 4, refer to "Notice" on page 2B-1.

1. Flare to the fender.
2. One screw through the flare to fender center.
3. Nuts to the flare at each end inside the fender.

Tighten

- Flare to the fender nuts to 2.6 N·m (23 lbs. in.).
4. Flare to fender screws starting at the center.

Tighten

- Flare to fender screws to 1.9 N·m (17 lbs. in.).
5. Fender to the vehicle. Refer to "Fender Replacement."

REAR FENDER

Pickup Models

↔ Remove or Disconnect

1. Flare to fender screws.
2. Access plugs inside fender liner.
3. Fender to flare nuts.
4. Tire and wheel assembly. Refer to SECTION 3E.
5. Inner fender water deflector.
6. Hidden nuts between fender outer panel and inner wall of bed.

↔ Install or Connect

NOTICE: For steps 1, 3, and 4 refer to "Notice" on page 2B-1.

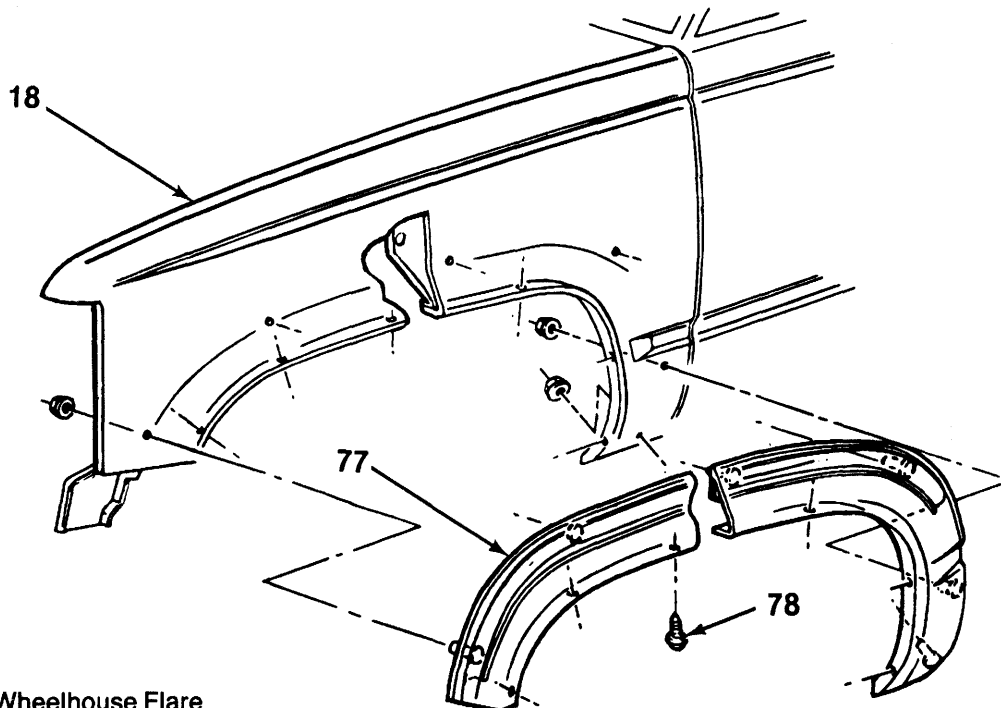
1. Hidden nuts between fender outer panel and inner wall of bed.

Tighten

- Flare to the fender nuts to 2.6 N·m (23 lbs. in.).
2. Inner fender water deflector.
 3. Fender to flare nuts.

Tighten

- Flare to the fender nuts to 2.6 N·m (23 lbs. in.).



18. Fender
77. Fender Wheelhouse Flare
78. Screw

F6580

Figure 18—Front Fender Flare

4. Flare to fender screws.



Tighten

- Flare to the fender screws to 1.9 N.m (17 lbs. in.).
5. Access plugs inside fender liner.
 6. Tire and wheel assembly. Refer to SECTION 3E.

Utility and Suburban Models



Remove or Disconnect

1. Flare to fender screws.
2. Rear seat blower motor cover (if equipped). Refer to SECTION 10A4.
3. Spare tire (left side only) (if equipped). Refer to SECTION 3E.
4. Quarter panel interior trim. Refer to SECTION 10A4.
5. Flare to quarter panel nuts from inside wheel well.
6. Flare from the vehicle.



Install or Connect

NOTICE: Refer to "Notice" on page 2B-1.

1. Flare to the vehicle with nuts and screws.



Tighten

- Flare to the fender nuts to 2.6 N.m (23 lbs. in.).
 - Flare to the fender screws to 1.9 N.m (17 lbs. in.).
2. Quarter panel interior trim. Refer to SECTION 10A4.
 3. Rear seat blower motor cover (if equipped). Refer to SECTION 10A4.

SHEET METAL SUPPORT



Remove or Disconnect (Figure 19)

1. Grille. Refer to "Grille Replacement."
2. Primary hood latch bracket. Refer to "Primary Hood Latch Replacement."
3. Horn from the sheet metal support.
4. Three sheet metal support to radiator support bolts.
5. Sheet metal support.



Install or Connect (Figure 19)

NOTICE: Refer to "Notice" on page 2B-1.

1. Sheet metal support to radiator support with three bolts.



Tighten

- Support to radiator support bolts to 25 N.m (18 lbs. ft.).
2. Horn to the support. Refer to SECTION 8D.

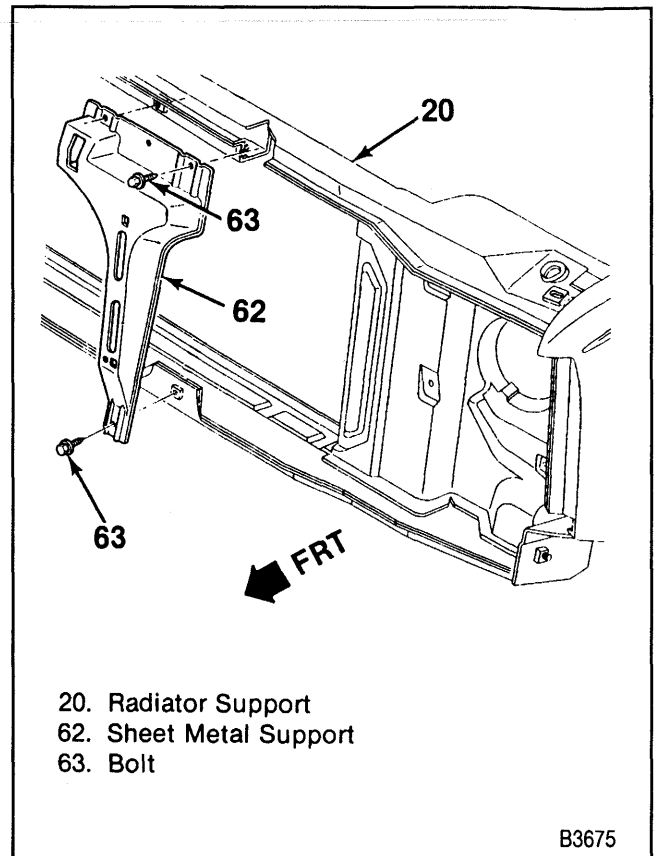


Figure 19—Sheet Metal Support

3. Primary hood latch bracket. Refer to "Primary Hood Latch Replacement."
4. Grille. Refer to "Grille Replacement."

RADIATOR SUPPORT



Remove or Disconnect (Figures 16, and 20 through 23)

1. Battery cables. Refer to SECTION 0A.
2. Battery(ies) and tray(s) from the wheel house(s).
3. Fan shroud.

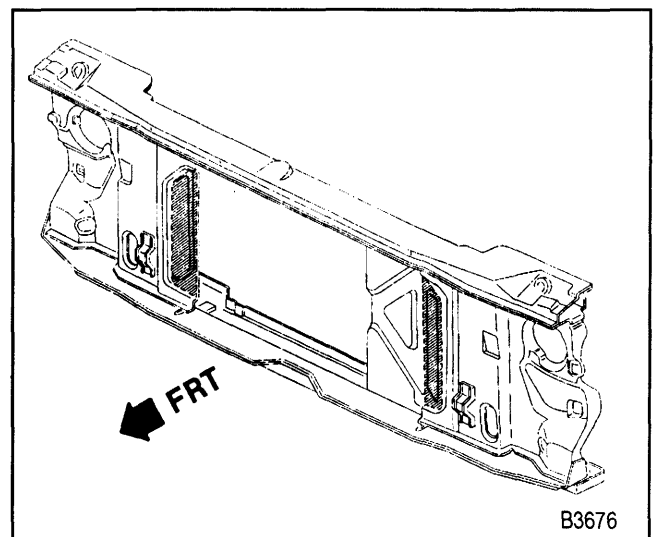


Figure 20—Radiator Support

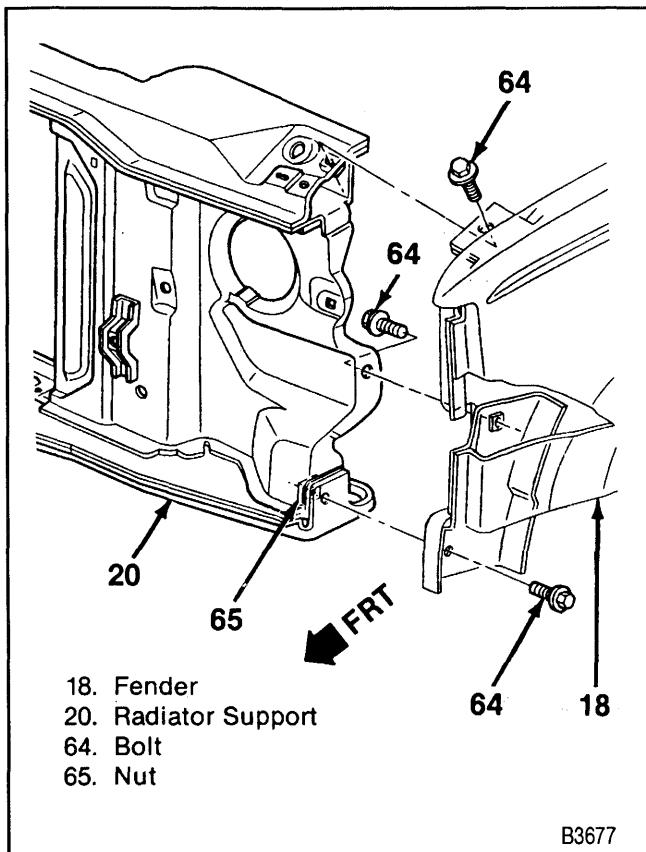


Figure 21—Fender to Radiator Support Attachment

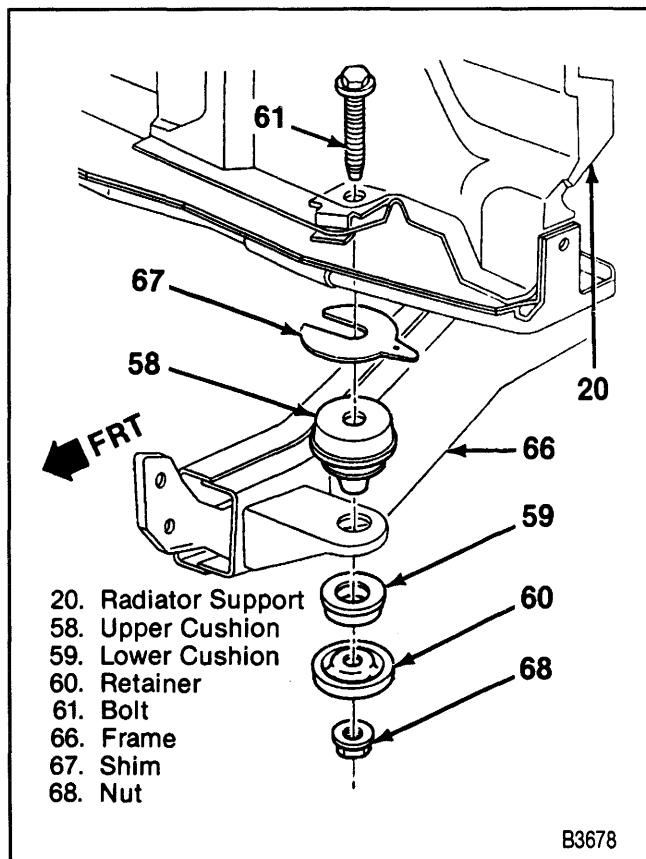


Figure 22—Radiator Support Mounting

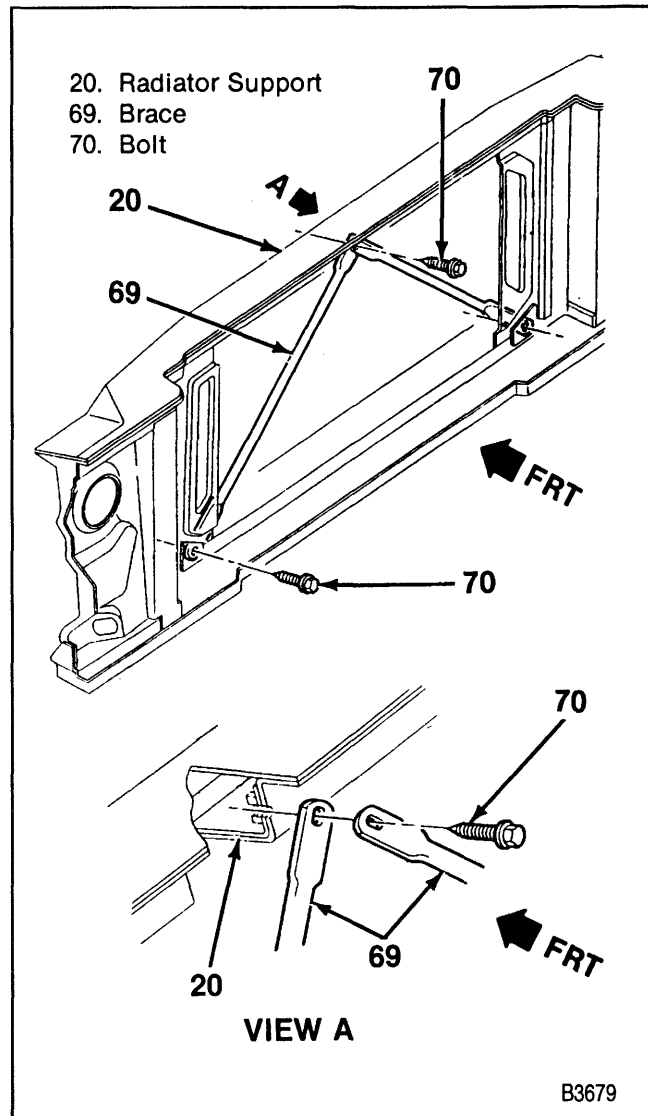


Figure 23—Radiator Support Braces

4. Radiator from the vehicle. Refer to SECTION 6B2.
5. Radiator grille. Refer to "Radiator Grille Replacement."
6. Headlamp and parking lamp connectors and harnesses from the radiator support.
7. Wiring harnesses from the clips at the front and back of the support.
8. Ground wires from the support.
9. Primary hood latch bracket from the sheet metal support.
10. Headlamps and parking lamps from the vehicle. Refer to SECTION 8B.
11. Horn from the sheet metal support.
12. Fuel vapor canister and lines from the radiator support.
13. Air conditioning condenser and lines, if equipped. Refer to SECTION 1B.
14. Wheelhouse panel to the radiator support bolts (figure 16).
15. Fender to the radiator support bolts (figure 21).
16. Air cleaner inlet from the right side of the radiator support.

17. Bolt holding the support mount to the vehicle (figure 22).
18. Radiator support from the vehicle.
19. Sheet metal support from the radiator support.
20. Support braces from the support (figure 23).

 Install or Connect (Figures 16, and 20 through 23)

NOTICE: For steps 1, 2, 5, 7, 8, and 20, refer to "Notice" on page 2B-1.

1. Braces to the radiator support with bolts.
 - Place the top of the left brace between the support and the right brace (figure 23).

 Tighten

- Brace to the radiator support bolts to 25 N.m (18 lbs. ft.).
2. Sheet metal support to the front of the radiator support with bolts.

 Tighten

- Support to radiator support bolts to 25 N.m (18 lbs. ft.).
3. Radiator support into the vehicle.
 4. Upper mounting cushion and shims between the support and the bracket on the frame (figure 22).
 - Level the support by placing shims below the support.
 - Shim pack height should not exceed 11 mm (0.43 inch).
 - The difference between the left and right shim pack height must not exceed 5 mm (0.19 inch).
 5. Bolt through the shims, upper cushion, frame bracket, lower cushion, retainer and nut.

 Tighten

- Radiator support mounting nut to 57 N.m (42 lbs. ft.).
6. Air cleaner inlet to the right side of the radiator support.
 7. Fender to the radiator support bolts (figure 20).

 Tighten

- Fender to support bolts to 25 N.m (18 lbs. ft.).
8. Wheelhouse to the radiator support bolts (figure 16).

 Tighten

- Wheelhouse to support bolts to 25 N.m (18 lbs. ft.).
9. Air conditioning condenser and lines, if equipped. Refer to SECTION 1B.
 10. Fuel vapor canister and lines from the radiator support.
 11. Horn to the sheet metal support. Refer to SECTION 8D.

12. Headlamps. Refer to SECTION 8B.
13. Primary hood latch bracket to the sheet metal support. Refer to "Primary Hood Latch Replacement."
14. Wiring harnesses into the clips on the front and back of the support.
15. Ground wires to the support.
16. Headlamp and parking lamp connectors to the lamps.
17. Radiator grille. Refer to "Radiator Grille Replacement."
18. Radiator. Refer to SECTION 6B2.
19. Fan shroud.
20. Battery tray to the wheelhouse.

 Tighten

- Battery tray to wheelhouse bolts to 25 N.m (18 lbs. ft.).
21. Battery(ies) and cables.

PICKUP BOX REPLACEMENT

 Remove or Disconnect (Figure 24)

1. Taillamp wiring connectors under the back of the box.
 - Open the cover to the gas cap.
2. Screws holding the neck of the gas filler tube to the side panel.
3. Eight bolts holding the box to the frame rails from under the box.
4. Pickup box from the vehicle.

 Install or Connect (Figure 24)

1. Pickup box to the vehicle.

NOTICE: Refer to "Notice" on page 2B-1.

2. Eight bolts holding the box to the frame rails, from inside the frame rails.

 Tighten

- Box to frame rail bolts to 70 N.m (52 lbs. ft.).
3. Neck of the gas filler tube to the side panel with screws.
 4. Wiring connectors to the taillamp assemblies under the back of the box.

SHEET METAL ADJUSTMENTS

In order to have the proper operation and appearance of sheet metal components, it is critical that certain fits and gaps between components be maintained. The gaps given in this procedure are suggested as the best alignment for these components (figure 25).

In aligning sheet metal, it is best to start with the rear most component, and work forward.

1. Starting with the fenders, align the rear edge of each fender to the rocker panel and the door. The gap between these components should be 5 mm $\pm$ 1.0 mm (0.19 inch $\pm$ 0.03 inch). This adjustment should be accomplished by moving the fender for-

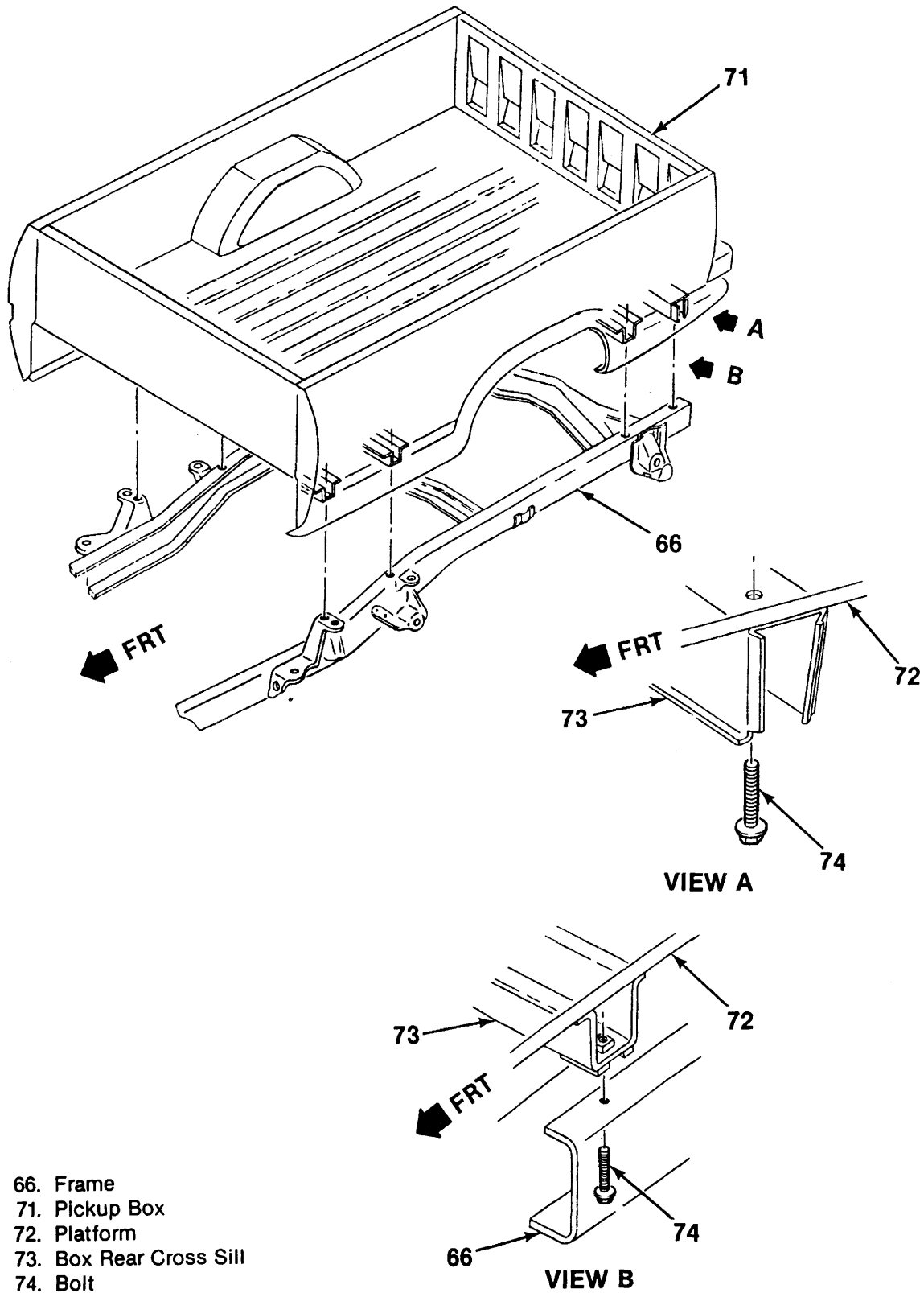
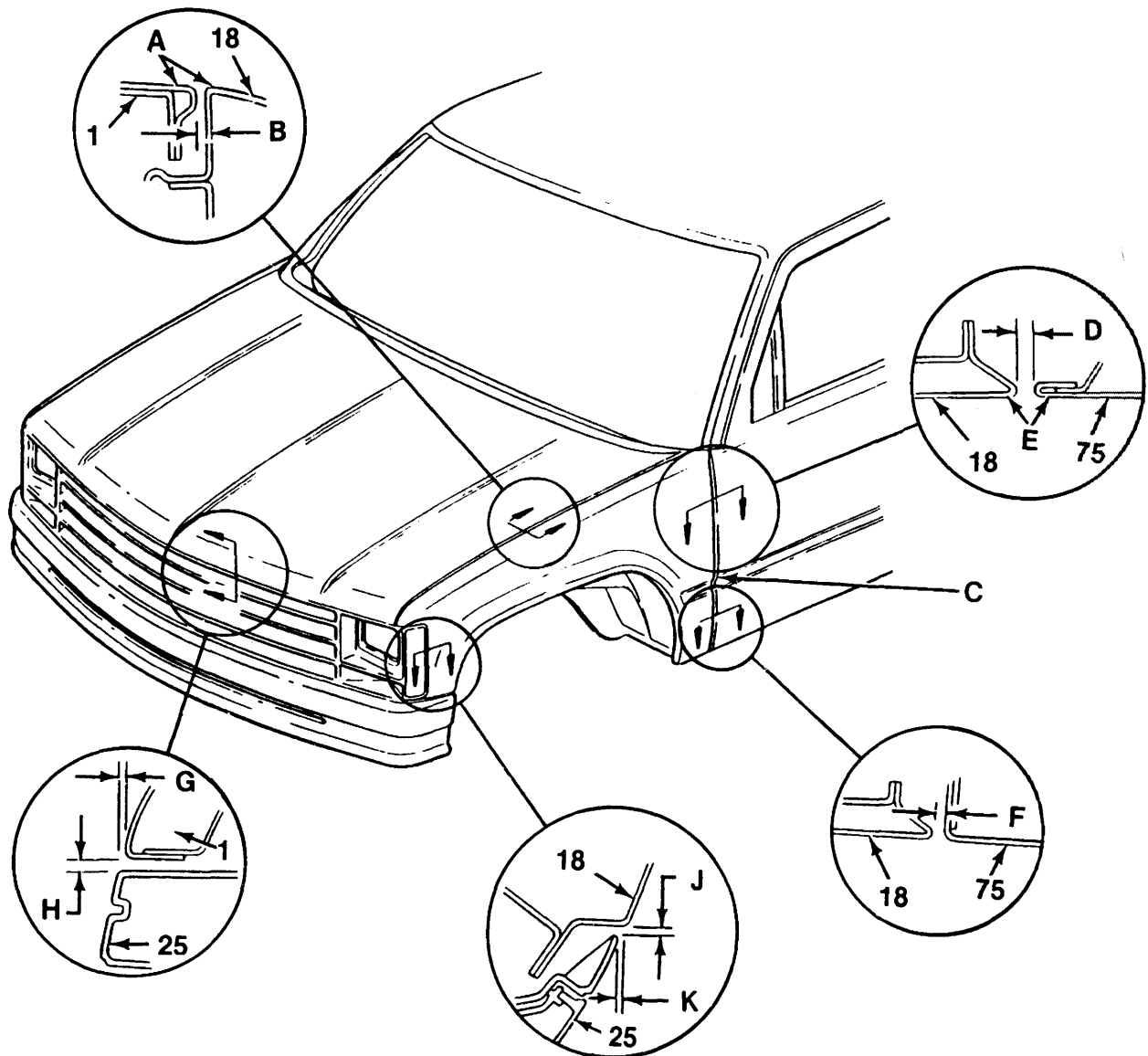


Figure 24—Pickup Box Mounting



- 1. Hood
- 18. Fender
- 25. Radiator Grille
- 75. Door

- A. Flush ± 1 mm (± 0.03 -inch)
- B. 4 mm ± 1.0 mm and parallel within 1.0mm (0.15-inch ± 0.03 -inch and parallel within 0.03-inch)
- C. Features lines flush ± 1.0 mm (± 0.03 -inch)
- D. 5 mm ± 1.0 mm and parallel within 1.0 mm (0.19-inch ± 0.03 and parallel within 0.03-inch)
- E. Flush ± 1 mm (± 0.03 -inch)
- F. 5 mm ± 1.0 mm (0.19-inch ± 0.03 -inch)
- G. 1.5 mm ± 1.0 mm (0.06-inch ± 0.03 -inch)
- H. 4.5 mm ± 1.0 mm and parallel within 1.0 mm (0.17-inch ± 0.03 -inch and parallel within 0.03-inch)
- J. 3.0 mm ± 1.0 mm and parallel within 1.0 mm (0.01-inch ± 0.03 -inch and parallel within 0.03-inch)
- K. 1.5 mm ± 3.0 mm and parallel within 1.0 mm (0.06-inch ± 0.01 -inch and parallel within 0.03-inch)

F5325

Figure 25—Sheet Metal Gap Specifications

ward or rearward. The surface of the fender should be flush with the rocker panel and the door. Add or remove shims to perform this adjustment.

2. Align the left and right edges of the hood so that a gap of 4.0 mm $\pm$ 1.0 mm (0.15 inch $\pm$ 0.03 inch) exists between the hood and fenders. The hood surface should be flush with the fender surface within +0.5 mm -1.5 mm (+0.02 inch - 0.06 inch). If this gap is difficult to obtain, and the hood appears to be cocked in between the fenders, the radiator support may need to be shifted. By shifting the radiator support, the entire front end sheet metal can be aligned as a unit. Loosen the support to the frame bolts, and shift the radiator support to obtain the proper gaps. Then, while holding the support in position, retighten the radiator support to frame bolts.
3. Align the front face of the hood with the radiator grille, so that there is a gap of 1.5 mm $\pm$ 1.0 mm (0.06 inch $\pm$ 0.03 inch) between the leading edge of the hood and the top of the radiator support. There should also be a 4.5 mm + 1.0 mm (0.17 inch + 0.03 inch) gap between the lower hood surface and the top of the radiator support. Adjust the hood bumpers on top of the radiator support to give the proper gap.

CAB MOUNT REPLACEMENT

When changing cab mounts, it is important to properly support the frame while changing the mount. If only one mount is to be changed, the side on which the mount is placed must be lowered enough to provide clearance for the mount.

Remove or Disconnect (Figure 26)

- A. Raise the vehicle slightly on the hoist.
 - B. Place jack stands under the cab on the side of the vehicle where the mounts will be replaced.
 - C. Loosen mounting bolts on that side.
1. Mounting bolt.
 2. Lower cushion retainer.
 3. Lower cushion.
 - Lower the hoist enough to leave the cab supported by the jacks.
 4. Upper cushion.

Install or Connect (Figure 26)

1. Upper cushion.
 - Raise the frame slightly on the hoist.
2. Lower cushion.
3. Lower cushion retainer.

NOTICE: Refer to "Notice" on page 2B-1.

4. Mounting bolt.
 - Remove the jacks.

Tighten

- Mounting bolt to 75 N.m (55 lbs. ft.).
- Lower the hoist.

ADHESIVE-RETAINED MOLDINGS, APPLIQUES, AND EMBLEM REPLACEMENT

These items should be applied in an environment free of dust or dirt that could come in contact with the sticky backing and prevent proper adhesion.

1. Clean the area where the replacement item is to be mounted (figure 27). Use a suitable solvent such as flash naphtha or a mixture of 50 percent isopropyl/alcohol and 50 percent water. Dry the area thoroughly.
2. The body area must be a temperature range of 27° to 41° C (80° to 105°F). Heat the area if necessary.
3. The item to be mounted must be at a temperature of 29° to 32°C (80° to 90°F). Carefully apply heat to the item if needed.
4. Remove the protective liner.

Moldings and Appliques

- A. Press the molding to the body along its entire length at a pressure of 13.3 to 44.5 N (3 to 10 lbs.).
- B. Tape clear plastic, 0.12 mm (0.005 inch) thick, over the item and apply high pressure along the entire area to wet out about 75 percent of the adhesive.

Emblems

- Emblems can be clamped to the body at the center of the emblem. Place foam between the clamp and the emblem to protect it.

FENDER PROTECTORS

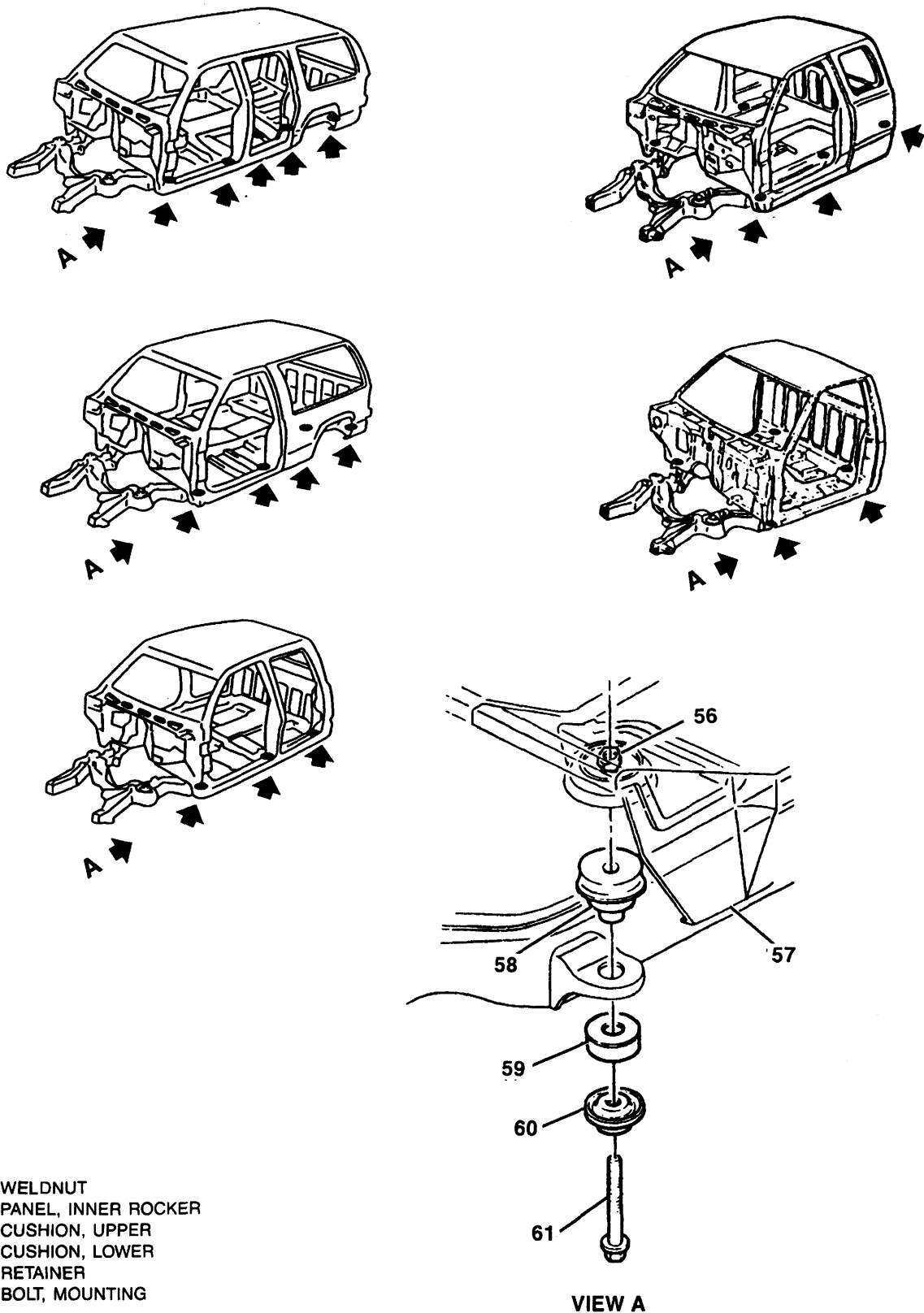
Application

1. Be sure the fender is clean (figure 28).
2. Mix a solution of 50 percent isopropyl alcohol and 50 percent water. Spray the solution on the fender where the protector is to be mounted or on the adhesive side of the protector.
3. Mount the protector, working out any wrinkles or bubbles. Be sure the protector does not extend over the edge of the flange.
4. The tape should not be peeled more than 10 seconds prior to usage.

DECAL REPLACEMENT

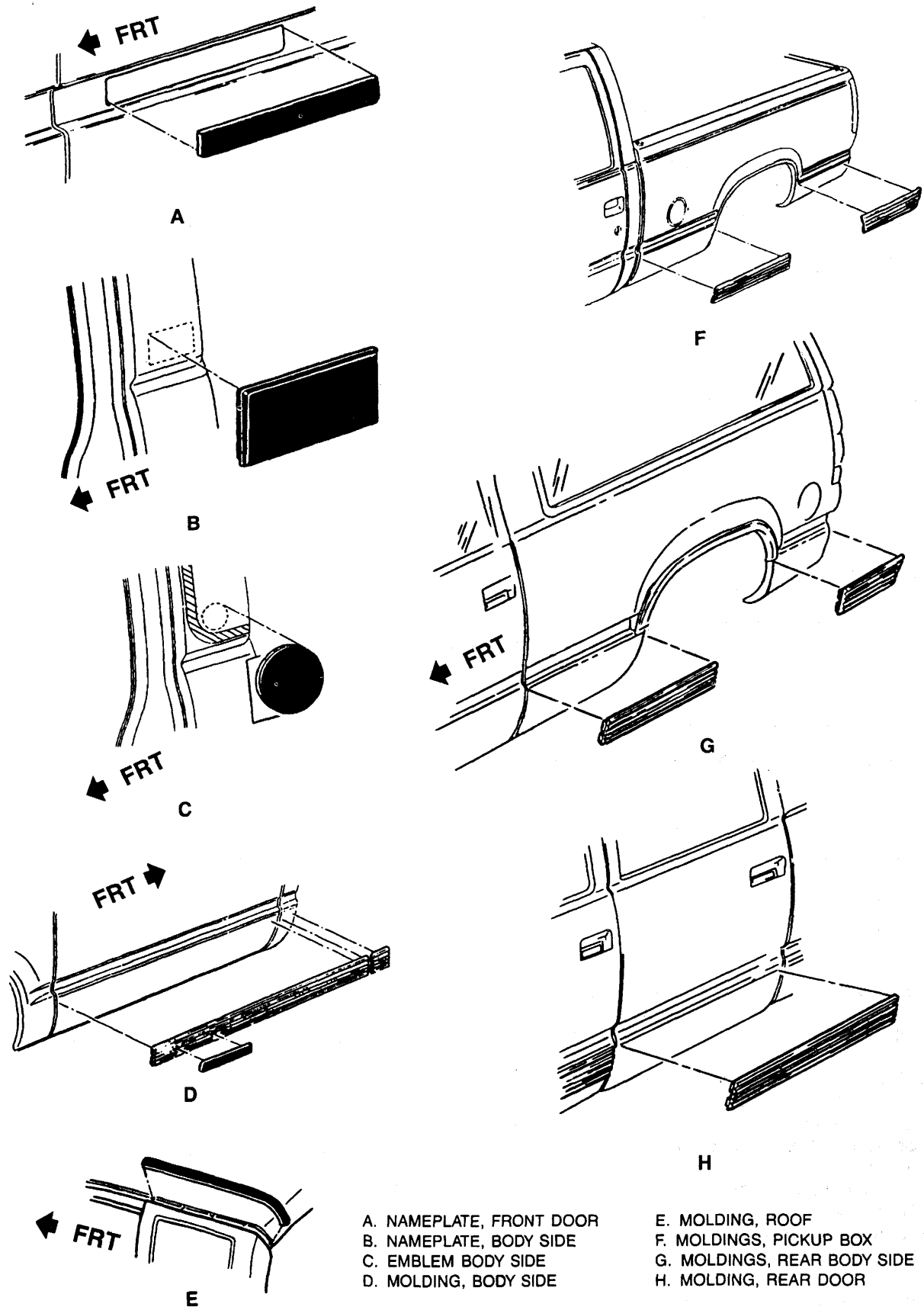
Decals should be applied in a clean environment where dust or fibers will not interfere with proper adhesion.

1. Clean the area where the decal will be mounted. Use a suitable solvent such as flash naphtha or a mixture of 50 percent isopropyl alcohol and 50 percent water. Dry the area thoroughly. If paint in the area is chipped, repaint the area and feather it in.
2. The body surface and the decal must be warmed to 27° to 38°C (80° to 100°F).
3. Most stripes and decals can be applied dry as long as this results in a bubble-free application. Stripes or decals that wrap into body openings or are to be mounted on flexible surfaces must be mounted wet.



V2350

Figure 26—Cab Mounts



A. NAMEPLATE, FRONT DOOR
B. NAMEPLATE, BODY SIDE
C. EMBLEM BODY SIDE
D. MOLDING, BODY SIDE

E. MOLDING, ROOF
F. MOLDINGS, PICKUP BOX
G. MOLDINGS, REAR BODY SIDE
H. MOLDING, REAR DOOR

Figure 27—Moldings and Emblems

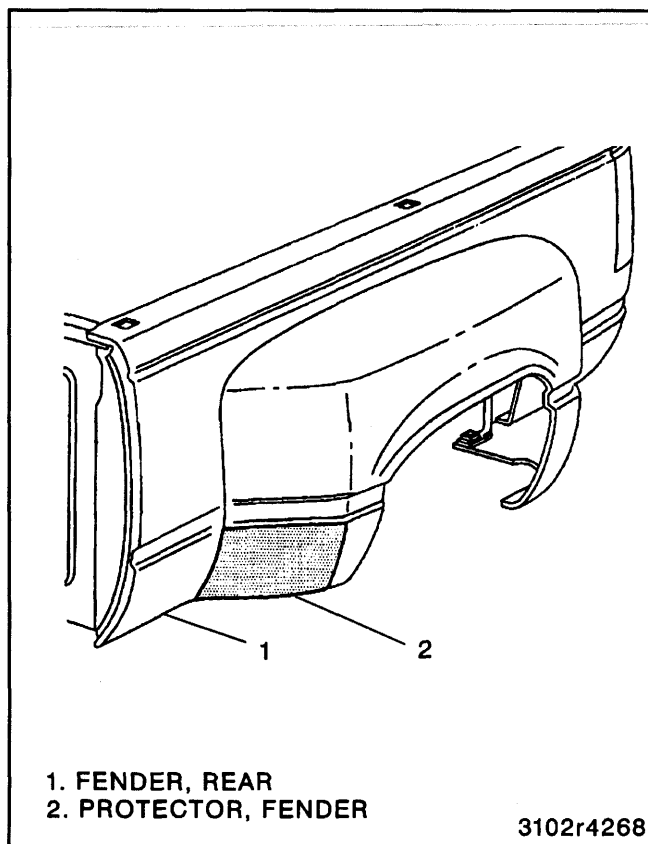


Figure 28—Fender Protectors

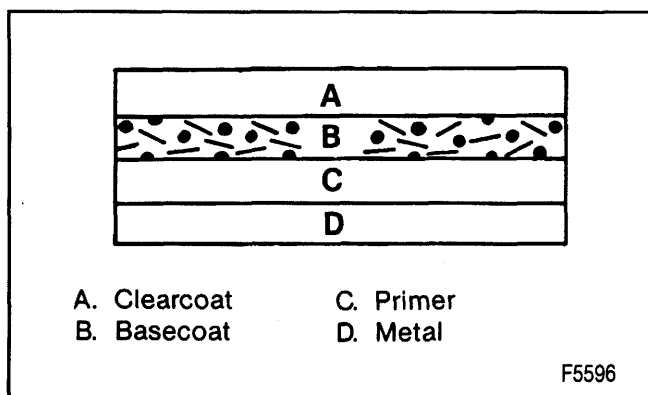


Figure 29—Basecoat/Clearcoat Finish

Wet Application

CAUTION: Duponol may cause irritation to the eyes, skin, or respiratory tract.

- Do not allow Duponol to contact the eyes or skin. Flush any contacted areas with water.
- Avoid inhaling fumes. Use in a well ventilated area.
- Avoid getting any Duponol on clothing. Wash clothing before reuse.

1. Use a wetting agent such as Dupont Duponol WA (or equivalent). Do not use a soap solution. Spray a mist of the solution onto the body area.
2. Remove the backing from the decal by peeling it away. In hot, humid weather, the adhesive back of

the decal can be sprayed with a mist of the wetting solution.

3. Using a squeegee and starting at the center of the decal, squeegee the decal onto the body, removing air bubbles and wetting solution.
4. Remove the premask from the decal by pulling it back onto itself. Do not lift the premask straight up.
5. Go over the decal again with the squeegee.
6. If air bubbles are still present, prick them with a pin.

ANTI-CORROSION TREATMENT

This vehicle was designed and built to resist corrosion. Application of additional rust-inhibiting materials is not necessary or required under the 6 year/100,000 mile corrosion coverage.

- Some after-market rustproofing may create a potential environment which reduces the corrosion resistance designed and built into this vehicle.
- Depending upon application technique, some after-market rustproofing could result in damage or failure of some electrical or mechanical systems of the vehicle.
- Repairs to correct damage or malfunctions caused by after-market rustproofing are not covered under any of the GM new vehicle warranties.

SHEET METAL REPAIR

To help prevent rust, special anti-corrosion materials are used on interior surfaces of metal panels. These materials include special metals such as one-sided and two-sided galvanized, zincrometal and zinc-iron alloy steels. These specially treated metals are used in fenders, doors, quarter panels, rocker panels, floor pans, and other critical areas.

Spray-on materials such as zinc-rich primers and waxes may also be applied to interior surfaces. These are mainly used in areas where moisture might gather. Sealers are applied along exposed joints and moisture-repelling asphaltic sound deadeners are applied inside wheel wells and doors, and on some underbody parts.

If, while repairing damaged areas these special treatments are disturbed, the metals may be left unprotected. This could lead to corrosion; therefore, these surfaces should be recoated with service-type anti-corrosion materials. Follow these steps in applying the materials.

1. Cleanup and Preparation

Depending on the location of the area, sandblasting, scraping, wire brushing, sandpaper, and steel wool can be used to remove residue.

2. Applying Primer Coats

Prime all bare metal with an acrylic chromate material.

3. Applying Sealers

Seal all flanged joints, overlap joints, and seams with a medium-bodied consistency sealer which stays flexible and is paintable.

All open joints which require bridging of sealer to close a gap should take a heavy-bodied caulking material.

4. Applying Color

If areas such as underbody, hem flanges, exposed joints and engine compartment need color, follow conventional refinishing preparation, undercoat buildup, and color application procedures. Rub-out and extensive sanding of the undercoats are not necessary.

5. Applying Deadeners

Use a heavy bodied undercoat with a rubberized or asphaltic base. Areas for application can be determined by original production application.

6. Applying Anticorrosion Material

Use a light-bodied material designed to penetrate between close metal-to-metal surfaces such as pinch weld joints, hem flanges, and other attaching points where metal surfaces are difficult to coat with conventional materials.

7. Conventional Undercoating

Apply to large areas such as doors, hoods, fenders, etc. Use care not to spray material into door hardware such as locks, run channels and window regulator.

On the underbody, the material should not be applied to any moving or rotating parts.

After undercoating, make sure that all body drain holes are open.

DINGING AND FINISHING

Paint is quickly scuffed off sharp dents leaving metal exposed to rusting and corrosion; therefore, damaged

panels should be repaired as soon as possible. Repair damaged panels by forcing outward in the direction opposite to the force which caused the damage. In this way, metal strains that began when the damage occurred, are relieved.

The importance of proper metal finishing to produce a fairly smooth surface should not be underestimated. The application of a hammer directly to the panel tends to stretch the metal and cause a great deal of unnecessary work. Whenever possible, use a spoon under the hammer when bumping a panel.

ANTI-CHIP COATING REPLACEMENT

An anti-chip coating was applied to the lower portion of the vehicle from behind the front wheels to the back of the vehicle before the color coat application. When these areas are being repaired the anti-chip coating should be applied before the paint.

1. Clean the area with a wax remover.
2. Sand the old paint and anti-chip material away. Feather the edges of the area being treated.
3. If the coating is hard to remove, a heat gun and a putty knife can be used to strip it.
4. Apply primer to the area.
5. Apply the new anti-chip coating following the manufacturer's directions.

PAINT

CAUTION: Many paint repair systems require additives containing isocyanates. It is essential that all recommendations and warnings listed on the container label for materials selected be followed. It is mandatory that adequate respiratory protection such as air line respirators with a full hood be worn. Such protection should be worn during the entire painting process. Persons with respiratory problems or those allergic to isocyanates must not be exposed to isocyanate vapors or spray mist.

These vehicles have been finished with a basecoat/clearcoat paint process (figure 29). If repair or repainting is necessary, the technician should use refinishing methods appropriate to this process.

PAINT CODES

The following is a list of paint code numbers from various suppliers for the 1993 model year. These colors can be obtained locally.

Dupont refinish paints are available in:

- L - Lucite® - Acrylic Lacquer
- A - Centari® - Acrylic Enamel
- J - Cronar® - Polyoxithane Enamel
- K - Chromabase®
- 350S - Flexible Additive
- 310S - Black 123 Vinyl Lacquer - Chip Resistant

- 330S - White 123 Vinyl Lacquer - Chip Resistant



Important

- Vinyl Resin **MUST** be added to the base color when painting interior components.
 - DuPont Vinyl Resin #304—Instrument Panel
 - DuPont Vinyl Resin #305—All Remaining Interior Parts Except Seats
 - DuPont Vinyl Resin #306—Seats and Vinyl Roofs

When ordering DuPont paint, use "L", "A", "J", "K", 350S or 123 White or 123 Black with the appropriate DuPont code.

PPG (Ditzler) refinish paints are available in:

- DDL-Duracryl-Acrylic Lacquer or Acrylic Basecoat/Clearcoat
- DBU-Deltron-Basecoat/Clearcoat
- DAR-Delstar—Acrylic Enamel
- DAU-Deltron—Acrylic Urethane
- UCV-Vinyl Colors
- DX-369-Flexative-Flexible Finishes
- DX-54 Roadguard—Road Abrasion Protection

When ordering PPG (Ditzler) paint use DDL, DBU, DAR, DAU, UCV, DX-369, or DX-54 with the appropriate Ditzler code.

Sherwin-Williams, Acme, and Martin-Senour are available in acrylic lacquer, acrylic enamel, or acrylic urethane.

Sherwin-Williams use:

- prefix 34, J4 or L10 for acrylic lacquer
- prefix 35, J5, or F10 for acrylic enamel
- prefix U7 for acrylic urethane in a basecoat/clearcoat system
- prefix USS for acrylic urethane in a single stage system.

Acme Use:

- prefix 84 for acrylic lacquer
- prefix 85 for acrylic enamel
- prefix PB for acrylic urethane in a Basecoat/Clearcoat system
- prefix PS for acrylic urethane in a single stage system.

Martin-Senour: jobber will interchange number shown when acrylic lacquer is needed.

SPECIFICATIONS

EXTERIOR COLORS

GM Code	Fisher Code	Color	DuPont	BASF	PPG Ditzler	Martin Senour	Sherwin Williams
							Acme
10	9225	Ghost White	B8796	18121	4015	36783	36783
20	9790	Lt. Quasar Blue Metallic	B9322	23004	4714	46963	46963
30	158A	Atlantic Blue Metallic	B9427	24019	4813	48505	48505
36	9828	Med. Dk. Teal Metallic	B9222	22073	4347	45879	45879
38	9794	Bright Teal Metallic	B9307	22265	4716	46964	46964
39	9792	Indigo Metallic	B9323	23006	4717	46965	46965
41	8555	Black	99	13572	9700	82-5760	33756
50	8624	Olympic White	B8550	15255	3800	82-5918	34851
55	160A	Lt. Autumnwood Metallic	B9429	*	4817	48507	48507
56	161A	Dk. Autumnwood Metallic	B9430	24010	4818	48508	48508
74	9260	Victory Red	B8946	19030	4154	39339	39339
84	9927	Dk. Hunt Club Red Metallic	B9309	23007	4721	46969	46969
95	181A	Garnet Red Metallic	B8794	24024	4819	48509	48509
96	8867	Ultra Silver Metallic	B8795	18112	4023	36457	36457

*Not available at the time of printing.

T2096

FASTENER TIGHTENING SPECIFICATIONS

	N-m	Lbs. Ft.
Battery Tray Bolts	25	18
Brace to Radiator Support Bolts	25	18
Cab Mount Bolts	75	55
Dual Wheel Fender Nuts	25	18
Fender Bolts	25	18
Fender to Brace Bolts.....	17	13
Hinge to Fender Bracket Bolt.....	25	18
Hood Hinge Bolts.....	25	18
Link Assembly Bolts.....	25	18
Pickup Box to Frame Rail Bolts.....	70	52
Primary Hood Latch Bolts.....	25	18
Radiator Support to Frame Mounting Nut.....	57	42
Secondary Hood Latch Bolts.....	25	18
Sheet Metal Support to Radiator Support Bolts	25	18
Stepside Fender Screws.....	17	13
Wheelhouse Panel Bolts.....	25	18

T2097

NOTES

STEERING, SUSPENSION, TIRES AND WHEELS

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SECTION 3A

FRONT WHEEL ALIGNMENT

***NOTICE:** When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.*

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3A-2 FRONT WHEEL ALIGNMENT

GENERAL DESCRIPTION

Front wheel alignment refers to the angular relationship between the front wheels, the front suspension attaching parts, and the ground.

Proper front wheel alignment must be maintained in order to ensure efficient steering, good directional stability, and prevent abnormal tire wear.

The most important factors of front wheel alignment are wheel toe-in, wheel camber, and axle caster (figure 1).

DEFINITION OF TERMS

Caster (Figure 1)

Caster is the tilting of the steering axis either forward or backward from vertical when viewed from the side of the vehicle. A backward tilt is measured in positive degrees and a forward tilt in negative degrees.

On the short and long arm type suspension, you cannot see a caster angle without a special instrument. However if you look straight down from the top of the upper control arm to the ground, the ball joints do not line up (fore and aft) when a caster angle other than 0 degrees is present. With a positive angle, the lower ball joint center line would be slightly ahead (toward the front of the vehicle) of the upper ball joint center line. Caster is designed into the front axle assembly on all vehicles, and is intended to be non-adjustable. However, if the caster is measured and found to be out of tolerance, the caster can be set to proper specifications.

Camber (Figure 1)

Camber is the inward or outward tilting of the front wheels from vertical. When the wheels tilt outward at

the top, the camber is positive. When the wheels tilt inward at the top, the camber is negative. The amount of tilt measured in degrees from vertical is called the camber angle. Camber is designed into the front axle assembly of all vehicles and is intended to be non-adjustable. However, if the camber is measured and found to be out of tolerance, the camber can be set to proper specifications.

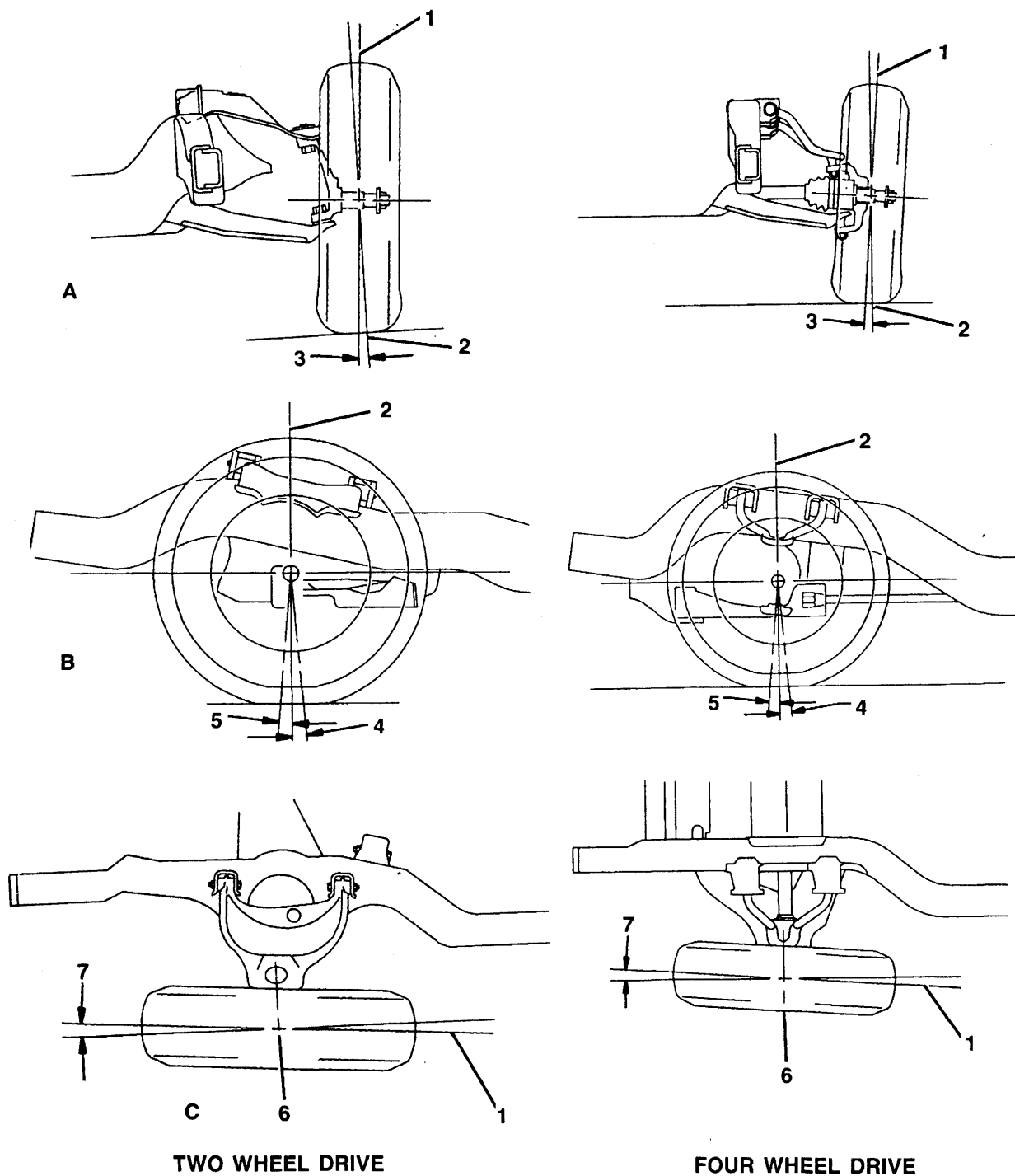
If camber is extreme or unequal between the wheels, improper steering and excessive tire wear will result. Negative camber causes wear on the inboard side of the tire, while positive camber causes wear to the outboard side.

Toe-In

Linear sum toe-in results when the distance between the front wheels is less at the front of the axle than at the rear of the axle.

Angular toe-in is the angle of the front wheel centerlines, relative to the intersection of the forward projected vehicle center line.

The actual amount of toe-in is normally a fraction of a degree. Toe-in is measured from the center of the tire treads or from the inboard side of the tires. The purpose of toe-in is to ensure parallel rolling of the front wheels and to offset any small deflections of the wheel support system which occur when the vehicle is rolling forward. Incorrect toe-in can cause unstable steering and front tire wear. Toe-in is the last alignment to be set in the front wheel alignment procedure.



A. CAMBER

B. CASTER

C. TOE-IN

1. CENTER LINE OF WHEEL

2. VERTICAL REFERENCE LINE

3. CAMBER (POSITIVE)

4. CASTER (NEGATIVE)

5. CASTER (POSITIVE)

6. AXIAL CENTER LINE OF WHEEL

7. TOE-IN (POSITIVE)

Figure 1—Caster, Camber, and Toe-In Angles

3A-4 FRONT WHEEL ALIGNMENT

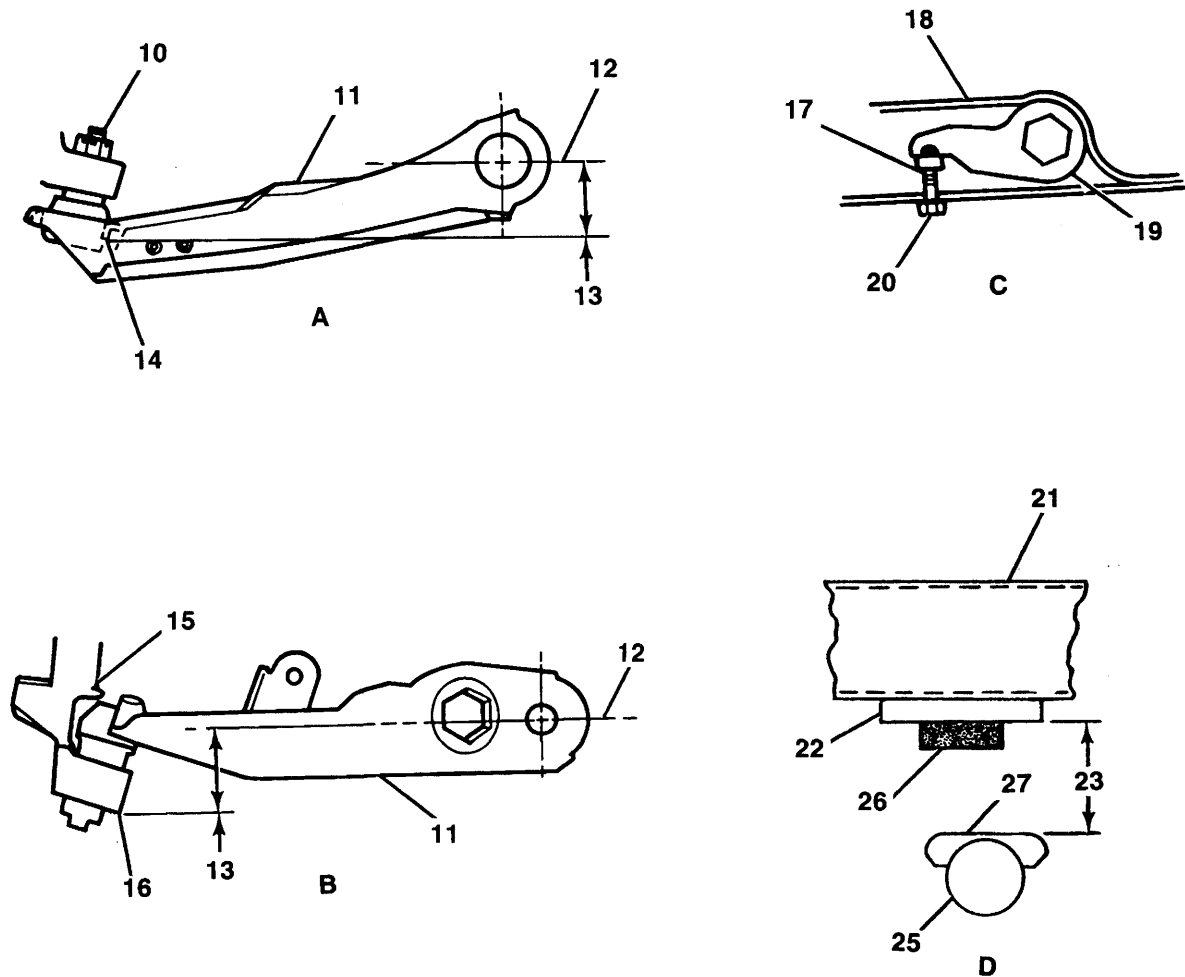
PRELIMINARY INSPECTIONS

Before making any adjustments affecting caster, camber, or toe-in, inspect front end as follows:



Inspect (Figure 2)

- Tires for proper inflation pressure. Refer to SECTION 3E.
- Front wheel bearing for proper adjustment. Refer to SECTION 3C.
- Ball joints, tie rod ends, and relay rods. If excessive looseness is noted, correct before adjusting. Refer to SECTION 3B3.
- Wheels and tires for runout. Refer to SECTION 3E.
- Dimension "Z" in (figure 2). If not within specifications, the correction must be made before adjusting caster.
- Steering gear for looseness at the frame.
- Shock absorbers for leaks or any noticeable noise. Refer to SECTION 3C.
- Control arms or stabilizer shaft attachments for looseness. Refer to SECTION 3C.
- Alignment equipment. Follow the manufacturer's instructions.
- Level of the vehicle. The vehicle must be on a level surface fore and aft and side to side.
- Excess drag or poor return of steering wheel due to stiff or rusty suspension or linkage components.



- A. "C" MODEL
- B. "K" MODEL
- C. "K" MODEL TORSION BAR ADJUSTER
- D. "CK" MODEL REAR SUSPENSION
- 10. LOWER BALL JOINT
- 11. LOWER CONTROL ARM
- 12. PIVOT BOLT CENTER LINE
- 13. "Z" HEIGHT
 - C 1,2,3 95.0 ± 6.0mm
 - K 1,2 157.0 ± 6.0mm
 - K 3 145.0 ± 6.0mm
- 14. LOWER BALL JOINT EXTRUSION
- 15. STEERING KNUCKLE

- 16. STEERING KNUCKLE LOWER CORNER
- 17. NUT
- 18. TORSION BAR SUPPORT ASM.
- 19. TORSION BAR ADJUSTMENT ARM
- 20. BOLT—ONE TURN EQUALS 6mm HEIGHT CHANGE
- 21. FRAME
- 22. BOTTOM SURFACE OF JOUNCE BRACKET
- 23. "D" HEIGHT
- 25. REAR AXLE
- 26. JOUNCE BUMPER

Figure 2—Trim Heights

3A-6 FRONT WHEEL ALIGNMENT

DIAGNOSIS OF FRONT WHEEL ALIGNMENT

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noisy Front Suspension	1. Worn tie rod ends. 2. Loose suspension bolts. 3. Lack of proper lubrication. 4. Loose shock absorbers or worn bushings. 5. Loose stabilizer shaft or worn insulators.	1. Replace the ends. 2. Refer to SECTION 3C. 3. Refer to SECTION 0B. 4. Tighten bolts and/or replace bushings. 5. Tighten bolts and/or replace insulators.
Wheel Bounce	1. Wheel and tire out of balance. 2. Blister or bump on tire. 3. Improper shock absorber action. 4. Excessive wheel or tire runout. 5. Tire "Lead."	1. Refer to SECTION 3E. 2. Replace the tire. 3. Replace the shock absorber. 4. Refer to SECTION 3E. 5. Refer to SECTION 3E.
Low or Uneven Trim Height	1. Broken or sagging springs or torsion bars. 2. Overloaded or improperly loaded vehicle.	1. Replace the springs or adjust torsion bars. 2. Avoid overloading the vehicle.
Excessive Tire Wear	1. Failure to rotate tires. 2. Damaged shock absorbers. 3. Improper tire pressure. 4. Incorrect wheel alignment. 5. Overloaded or improperly loaded vehicle. 6. Broken or sagging springs or torsion bars. 7. Loose or worn stabilizer bushings.	1. Refer to SECTION 3E. 2. Replace the shock absorber. 3. Refer to SECTION 3E. 4. Align the wheels. 5. Avoid overloading the vehicle. 6. Replace the springs or adjust torsion bars. 7. Tighten stabilizer bushing brackets or replace stabilizer bushings.
Vehicle Leads To One Side Or The Other	1. Keep in mind the road and wind conditions. 2. Front end misaligned. 3. Unbalanced steering gear valve. If this is the cause, steering effort will be very light in direction of lead and heavy in opposite direction. 4. Steering shaft rubbing the inside diameter of the shaft tube.	1. Test the vehicle, going in both directions, on a flat road. 2. Adjust to specifications. 3. Replace the gear valve. 4. Align or replace the steering column.

D0302

ON-VEHICLE SERVICE

MEASURING FRONT WHEEL ALIGNMENT

Satisfactory vehicle operation may occur over a wide range of front wheel alignment settings. If the settings vary beyond tolerances, adjustments are advisable. Refer to "Specifications" in figures 6 and 7.

As originally installed, the upper control arm cannot be adjusted for camber or caster. However, if the camber or caster is out of tolerance, the alignment can be reset to specifications by removing knockouts in the upper control arm frame brackets. Refer to SECTION 3C for upper control arm removal procedure. Upon

removal of control arm, remove the inserts outboard from the inside of the bracket with J 38794 knockout removal tool. Refer to "Frame Bracket Knockout Removal" as outlined later in this section.



Important

Set the front wheel alignment to specifications while the vehicle is in its normally loaded condition. Vehicles which are consistently operated with heavy loads should have toe-in adjusted with the vehicle under heavy load. This procedure should result in longer tire life.



Measure

"Z" Height (Figure 2)

1. Lift the front bumper of the vehicle up about 38 mm (1.5 inches).
2. Gently remove your hands and let the vehicle settle on its own.
3. Repeat this operation twice more for a total of three times.
4. Measure the "Z" dimension.
5. Push the front bumper of the vehicle down about 38 mm (1.5 inches).
6. Gently remove your hands and let the vehicle rise on its own.
7. Repeat the operation twice more for a total of three times.
8. Measure the "Z" dimension.
9. Find the average of the high and low measurements. This is the true "Z" dimension.

"D" Height (Figure 2)

1. Lift the rear bumper of the vehicle up about 38 mm (1.5 inches).

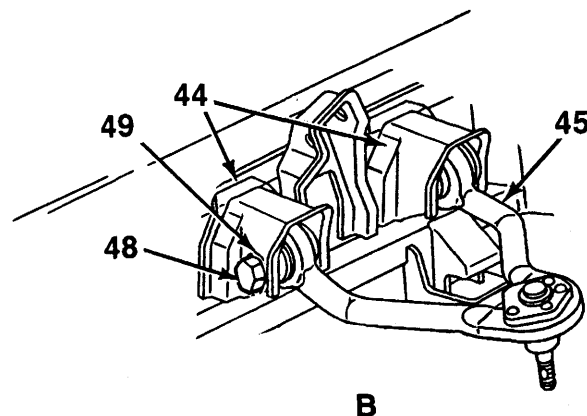
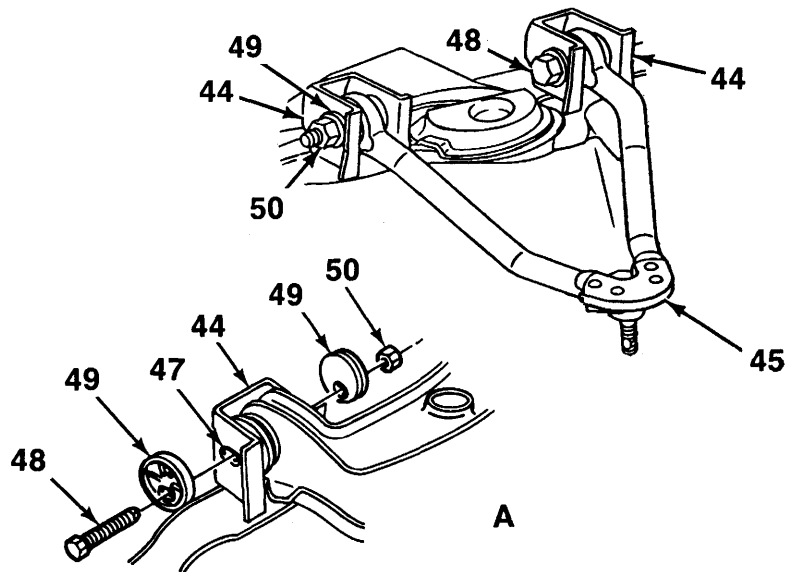
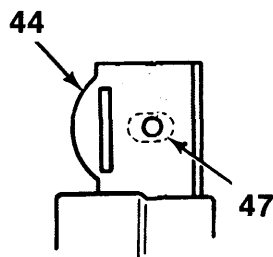
2. Gently remove your hands and let the vehicle settle on its own.
3. Repeat this operation twice more for a total of three times.
4. Measure the "D" dimension.
5. Push the rear bumper of the vehicle down about 38 mm (1.5 inches).
6. Gently remove your hands and let the vehicle rise on its own.
7. Repeat the operation twice more for a total of three times.
8. Measure the "D" dimension.
9. Find the average of the high and low measurements. This is the true "D" dimension.



Measure

• Front alignment angles

- Install alignment equipment according to the manufacturer's instructions.
- Measure alignment angles and record the readings. If adjustments are required, make them in the following order: caster, camber, and toe-in.



- A. "C" Models
- B. "K" Model
- 43. Bolt
- 44. Frame Bracket
- 45. Upper Control Arm
- 46. Frame
- 47. Knockout With Hole
- 48. Bolt With Flat Side
- 49. Cam
- 50. Nut

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Figure 3—Knockout Removal Two and Four Wheel Drive

3A-8 FRONT WHEEL ALIGNMENT

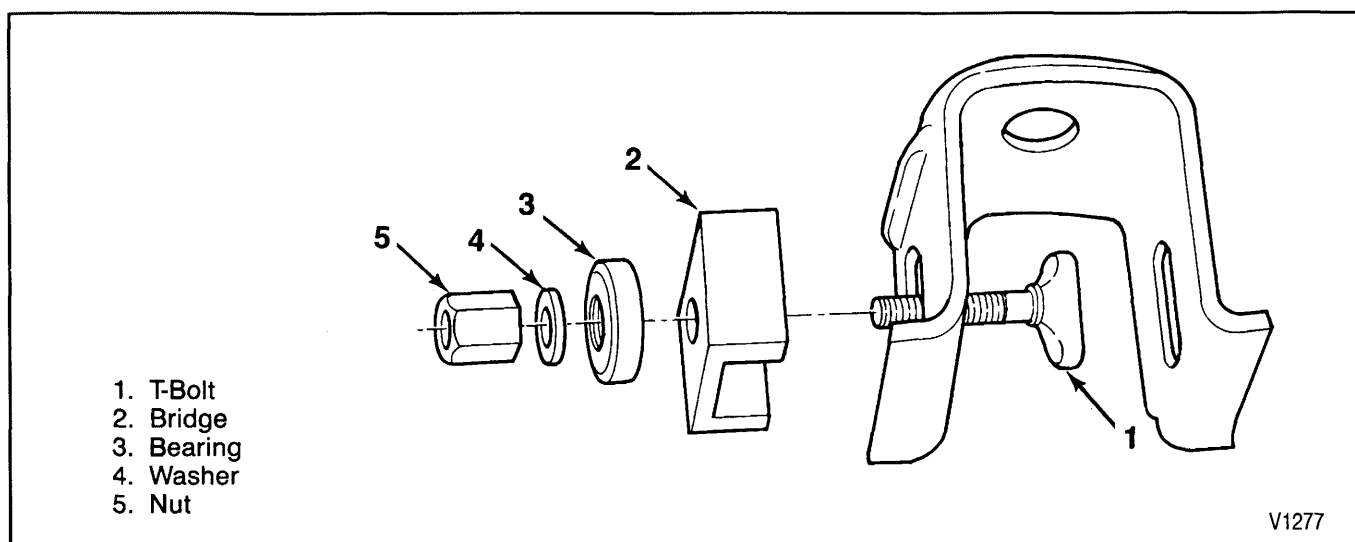


Figure 4—Knockout Tool Components

CASTER ADJUSTMENT

! Important

- All caster specifications are given with the vehicle frame level (zero angle).
- To make caster or camber adjustments the frame bracket knockouts must be removed. Refer to "Frame Bracket Knockout Removal."

1. Position the vehicle on a smooth level surface.
2. If needed, correct the "Z" dimension to the correct specification.
3. Measure the frame angle, using a bubble protractor or inclinometer. The frame angle is the tilt (in degrees) of the frame from the level position.
4. Note the frame angle as being "up in the rear" or "down in the rear."
5. Determine the caster angle from the alignment equipment.
6. Refer to figure 6 or 7 to determine the actual (corrected) caster reading. The following rules must be used for correcting the caster.
 - A. A "down in rear" frame angle must be subtracted from a positive caster reading.
 - B. An "up in rear" frame angle must be added to a positive caster reading.
 - C. A "down in rear" frame angle must be added to a negative caster reading.
 - D. An "up in rear" frame angle must be subtracted from a negative caster reading.
7. If the caster angle is wrong, remove the frame bracket knockouts. Refer to "Frame Bracket Knockout Removal."
8. Reset the caster angle by turning the cam bolts. Refer to specifications in figure 6 or 7.

CAMBER ADJUSTMENT

! Important

- To make caster or camber adjustments remove the frame bracket knockouts. Refer to "Frame Bracket Knockout Removal."

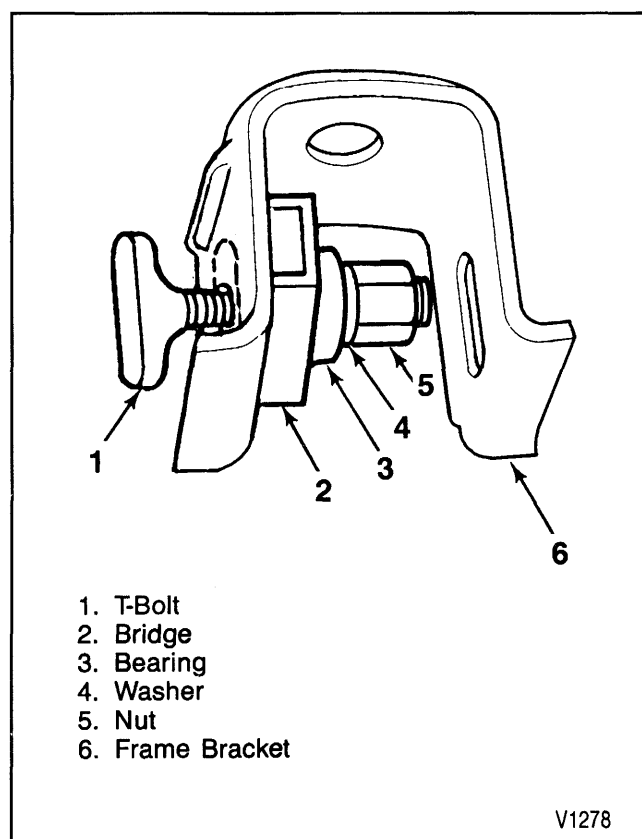


Figure 5—Knockout Tool Installed Inside Bracket

1. Determine the camber from the alignment equipment.
2. If camber angle is wrong, remove the frame bracket knockouts. Refer to "Frame Bracket Knockout Removal."
3. Reset the camber angle by turning the cam bolts. Refer to specifications in figure 6 or 7.

TOE-IN ADJUSTMENT

1. Determine the toe-in from the alignment equipment.
2. Change the length of both tie rod sleeves to affect a toe change. Toe-in can be increased or decreased by changing the length of the tie rod ends. A threaded sleeve is provided for this purpose. When the tie rod ends are mounted ahead of the steering knuckle they must be decreased in length in order to increase toe-in. When the tie rod ends are mounted behind the steering knuckle they must be lengthened in order to increase toe-in. Refer to SECTION 3B3 for clamping instructions.

FRAME BRACKET KNOCKOUT REMOVAL

As originally installed, the upper control arm cannot be adjusted for caster or camber. However, if the caster or camber is measured and found to be out of tolerance, the caster and camber can be set to the proper specifications.

Two Wheel Drive (C-Models)



Remove or Disconnect (Figure 3)

Tools Required:

J 38794 Knockout Removal Tool

- Raise and support the vehicle.
- Support the lower control arms with jack or jack stands.



Important

- The jack or stand must remain under the lower control arm during the removal and installation procedure in order to retain the lower control arm position.
1. Tire and wheel assembly.
 2. Nuts (50), cams (49), and bolts (48) from the upper control arm bracket (44).
 3. Lift upper control arm (45) up and to the side to gain access to the inner portion of the frame bracket.
 4. Frame bracket knockout using tool J 38794 (figure 4).
 - Do not distort frame bracket when removing knockout.
 - Apply extreme pressure lubricant to the threads of the T-bolt and insert the bolt through the knockout hole in the bracket support.
 - Install bridge onto T-bolt (figure 5). The forward bracket requires the bridge to be installed between the legs of the bracket due to access problems.
 - Assemble the bridge, bearing (chamfered side out), washer, and nut in order.
 - The T-bolt head and bridge must line up horizontally with the knockout; the bridge should span the knockout without interfering with the knockout procedure.
 - Tighten the T-bolt head against the knockout by turning the nut at the opposite end using a socket and torque wrench.
 - An open end or adjustable wrench may be needed to prevent the T-bolt from losing horizontal alignment with the knockout.

NOTICE: Do not subject the tool to more than 100 N.m (75 lbs. ft.) torque. Exceeding the recommended torque may damage the tool and/or the bracket.

- If the torque limit on the T-bolt is met and the knockout does not break free, use a die grinder of appropriate size. Using the stamped outline as a guide, remove the knockout. (Remove the wax coating in the knockout area to make the perforation lines more visible).
- If the outline is not visible, use the T-bolt head installed horizontally, as a template, and scribe the frame bracket.
- Repeat the procedure on the other upper control arm frame bracket.



Install or Connect (Figure 3)

1. Upper control arm (45) into frame brackets (44).
2. Bolts (48) and cams (49) through frame brackets (44), and control arm (45).
3. Cams (49) and nuts (50).
 - Install cams with radius toward frame brackets.
4. Partially tighten nut (50).
5. Front wheel assemblies.
6. Alignment machine heads.



Important

- Check "Front Wheel Alignment Specifications" in figure 6 and 7 for special requirements and alignment adjustments. Check trim height "Z" and "D." Verify alignment specifications before proceeding.



Adjust

- Caster and camber to the correct specifications by rotating the bolt head installed through adjuster cam.

NOTICE: Refer to "Notice" on page 3A-1.



Tighten

- A. Front upper control arm nuts (50) to 190 N.m (140 lbs. ft.).
 - B. Rear upper control arm nuts (50) to 190 N.m (140 lbs. ft.).
- Set steering wheel on center, with wheels straight, and loosen adjuster sleeve nuts.



Adjust

- Toe-in. Refer to "Specifications" in figures 6 and 7.

NOTICE: Refer to "Notice" on page 3A-1.



Tighten

- Tie rod adjuster sleeve nuts to 19 N.m (14 lbs. ft.).

3A-10 FRONT WHEEL ALIGNMENT

- Refer to SECTION 3B3 for proper position of clamps.
- Recheck alignment specifications.
- Lower the vehicle.

Four Wheel Drive (K-Models)

Remove or Disconnect (Figure 3)

Tools Required:

J 36202 Torsion Bar Unloading Tool
J 38794 Knockout Removal Tool

- Raise and support the vehicle.
- Support the lower control arms with jack or jack stands.

1. Tire and wheel assembly.
2. Adjustment assembly on torsion bar.

- Mark the adjustment bolt setting
- Increase the tension on the adjustment arm using J 36202
- Remove the adjuster bolt.
- Relax tension on torsion bar.

Important

- The jack or stand must remain under the lower control arm torsion bar seat during the removal and installation procedure in order to retain the lower control arm position.
3. Nuts (50), cams (49), and bolts (48) from the upper control arm bracket (44).
 4. Lift upper control arm (45) up and to the side to gain access to the inner portion of the frame bracket.
 5. Frame bracket knockout using tool J 38794 (figure 4).
 - Do not distort the frame bracket when removing the knockout.
 - Apply extreme pressure lubricant to the threads of the T-bolt and insert the bolt through the knockout hole in the bracket support.
 - Install bridge onto the T-bolt (figure 5). The forward bracket requires the bridge to be installed between the legs of the bracket due to access problems.
 - Assemble the bridge, bearing (chamfered side out), washer, and nut in order.
 - The T-bolt head and bridge must line up horizontally with the knockout; the bridge should span the knockout without interfering with the knockout procedure.
 - Tighten the T-bolt head against the knockout by turning the nut at the opposite end using a socket and torque wrench.
 - An open end or adjustable wrench may be needed to prevent the T-bolt from losing horizontal alignment with the knockout.

NOTICE: Do not subject the tool to more than 100 N.m (75 lbs. ft.) torque. Exceeding the recommended torque may damage the tool and/or the bracket.

- If the torque limit on the T-bolt is met and the knockout does not break free, use a die grinder of appropriate size. Using the stamped outline as a guide, remove the knockout. (Remove the wax coating in the knockout area to make the perforation lines more visible).
- If the outline is not visible, use the T-bolt head installed horizontally, as a template, and scribe the frame bracket.
- Repeat the procedure on the other upper control arm frame bracket.

Install or Connect (Figure 3)

1. Upper control arm (45) into frame brackets (44).
2. Bolts (48) and cams (49) through frame brackets (44), and control arm (45)
3. Cams (49) and nuts (50).
 - Install cams with radius toward frame brackets.
4. Partially tighten nut (50).
5. Front wheel assemblies.
 - A. Adjustment assembly on torsion bar.
 - Increase the tension on the adjustment arm using J 36202.
 - Adjuster bolt to adjustment mark.
 - Relax tension on torsion bar.
6. Alignment machine heads.

Important

- Check "Front Wheel Alignment Specifications" in figure 6 and 7 for special requirements and alignment adjustments. Check trim height "Z" and "D." Verify alignment specifications before proceeding.

Adjust

- Caster and camber to the correct specifications by rotating the bolt head installed through adjuster cam.

NOTICE: Refer to "Notice" on page 3A-1.

Tighten

- A. Front upper control arm nuts (50) to 190 N.m (140 lbs. ft.).
 - B. Rear upper control arm nuts (50) to 190 N.m (140 lbs. ft.).
- Set steering wheel on center, with wheels straight, and loosen adjuster sleeve nuts.

Adjust

- Toe - Refer to "Specifications" in figure 6 and 7.

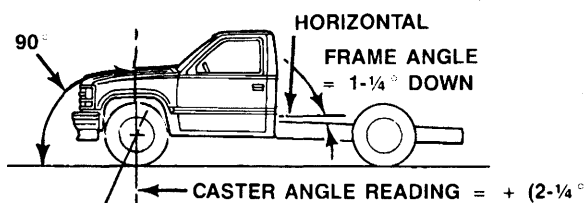
NOTICE: Refer to "Notice" on page 3A-1.

Tighten

- Tie rod adjuster sleeve nuts to 19 N.m (14 lbs. ft.).
- Refer to SECTION 3B3 for proper position of clamps.
- Recheck alignment specifications.
- Lower the vehicle.

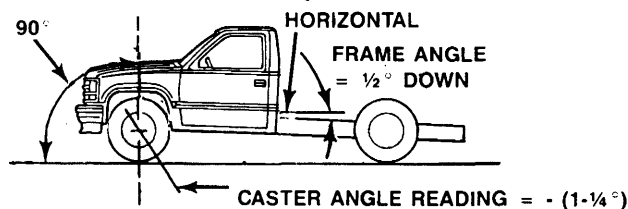
C-MODEL ALIGNMENT SPECIFICATIONS

D. A "DOWN IN REAR" frame angle must be SUBTRACTED from a POSITIVE caster reading.



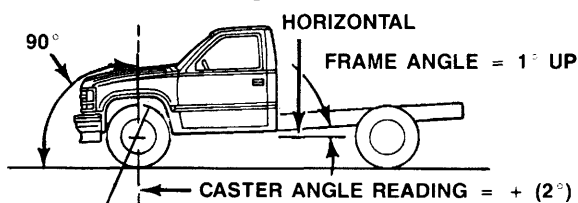
ACTUAL (CORRECTED) CASTER ANGLE = + (1°)

F. A "DOWN IN REAR" frame angle must be ADDED to a NEGATIVE caster reading.



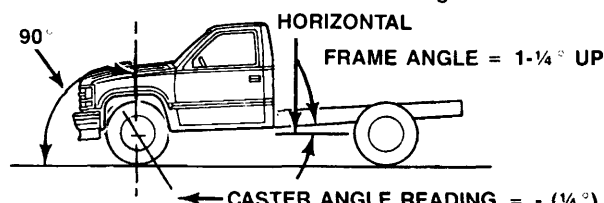
ACTUAL (CORRECTED) CASTER ANGLE = +- (1-3/4°)

E. A "UP IN REAR" frame angle must be ADDED to a POSITIVE caster reading.



ACTUAL (CORRECTED) CASTER ANGLE = + (3°)

G. A "UP IN REAR" frame angle must be SUBTRACTED from a NEGATIVE caster reading.



ACTUAL (CORRECTED) CASTER ANGLE = + (1°)

TO ALIGN	(A) AS SHIPPED			(A) CURB		
	FACTORY TARGET	FACTORY AUDIT		SERVICE CHECKING	SERVICE SETTING (E)	
	C100 200 300	C 100 200 300		C 100 200 300	C 100 200 300	
CASTER (DEGREES)	3.75° (B)	3.75° ± 1.0° (C)		3.75° ± 2.0° (C)	3.75° ± 1.0° (B)	
CAMBER (DEGREES)	.5° (B)	.5° ± .6° (C)		.5° ± 1.0° (C)	.5° ± .5° (B)	
(SUM TOE DEGREES)	.24° (D)	.24 ± .2° (D)		.24° ± .2° (D)	.24° (D)	

NOTE: VEHICLE MUST BE JOUNCED 3 TIMES BEFORE CHECKING ALIGNMENT TO ELIMINATE FALSE GEOMETRY READINGS.



IMPORTANT: CASTER ANGLE MUST BE CORRECTED TO LEVEL FRAME ANGLE.

- A. FRONT SUSPENSION (Z) DIMENSION IS HELD AS INDICATED IN "TRIM HEIGHTS" CHART.
- B. LEFT AND RIGHT SIDE TO BE EQUAL WITHIN .50°.
- C. LEFT AND RIGHT SIDE TO BE EQUAL WITHIN 1.0°.
- D. TOE-IN LEFT AND RIGHT SIDE TO BE SET EQUALLY PER WHEEL AND STEERING WHEEL MUST BE HELD IN STRAIGHT AHEAD POSITION WITHIN ± 5.0°.

I-BEAM FRONT SUSPENSION

TO ALIGN	FACTORY TARGET	FACTORY AUDIT	SERVICE CHECKING	SERVICE SETTING
CASTER (DEG)	+5 (E)	(E)	(E)	(E)
CAMBER (DEG)	+1.25 (E)	+1.25 ± .5 (E)	+1.25 ± .5 (E)	+1.25 ± .5 (E)
SUM TOE-IN (IN)	.03 IN	.03 ^{+0.0} -.03 IN	.06 IN ± .06 IN	.06 IN ± .06 IN
SUM TOE-IN (DEG)	.06°	.06° ^{+0.0°} -.06°	.12° ± .12°	.12° ± .12°

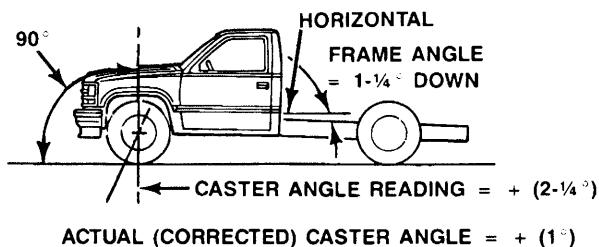
(E) Nominal: Reference only, no means of adjustment provided.

Figure 6—Two Wheel Drive (C-Model) Alignment Specifications

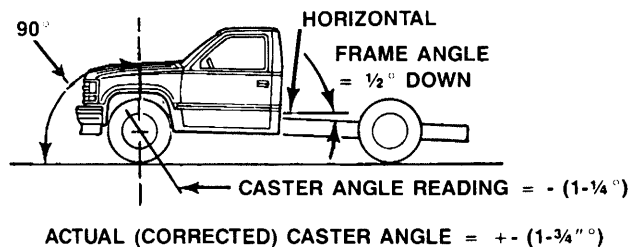
3A-12 FRONT WHEEL ALIGNMENT

K-MODEL ALIGNMENT SPECIFICATIONS

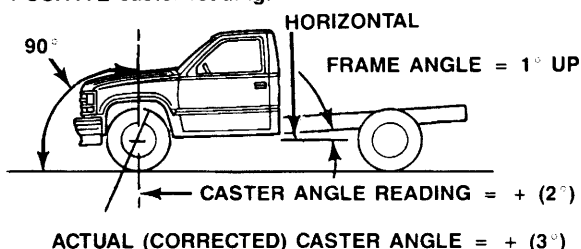
D. A "DOWN IN REAR" frame angle must be SUBTRACTED from a POSITIVE caster reading.



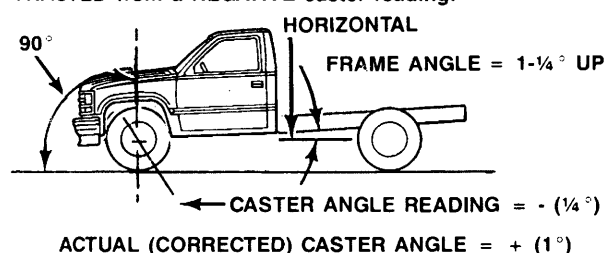
F. A "DOWN IN REAR" frame angle must be ADDED to a NEGATIVE caster reading.



E. A "UP IN REAR" frame angle must be ADDED to a POSITIVE caster reading.



G. A "UP IN REAR" frame angle must be SUBTRACTED from a NEGATIVE caster reading.



TO ALIGN	(A) AS SHIPPED				(A) CURB			
	FACTORY TARGET		FACTORY AUDIT		SERVICE CHECKING		SERVICE SETTING (E)	
	K100 K200 7200 LBS. GVW	K200 K300 8600 LBS. GVW	K100 K200 7200 LBS. GVW	K200 K300 8600 LBS. GVW	K100 K200 7200 LBS. GVW	K200 K300 8600 LBS. GVW	K100 K200 7200 LBS. GVW	K200 K300 8600 LBS. GVW
CASTER ° (DEGREES)	3.0° (B)	3.0° (B)	3.0° ± 1.0° (C)	3.0° ± 1.0° (C)	3.0° ± 1.0° (C)	3.0° ± 1.0° (C)	3.0° ± 1.0° (B)	3.0° ± 1.0° (B)
CAMBER DEGREES	.65° (B)	.50° (B)	.65° (C)	.65° (C)	.65° (C)	.65° (C)	.65° (B)	.65° (B)
(SUM TOE DEGREES)	.24° (D)	.24° (D)	.24° ± .2 (D)	.24° ± .2 (D)	.24° ± .2 (D)	.24° ± .2 (D)	.24° ± .2 (D)	.24° ± .2 (D)

NOTE: VEHICLE MUST BE JOUCED 3 TIMES BEFORE CHECKING ALIGNMENT TO ELIMINATE FALSE GEOMETRY READINGS.



IMPORTANT CASTER ANGLE MUST BE CORRECTED TO LEVEL FRAME ANGLE.

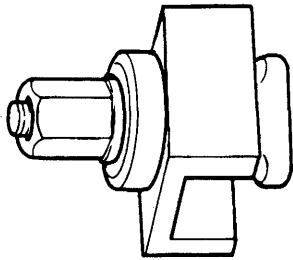
- A. FRONT SUSPENSION (Z) DIMENSION IS HELD AS INDICATED IN "TRIM HEIGHTS" CHART.
- B. LEFT AND RIGHT SIDE TO BE EQUAL WITHIN .50°.
- C. LEFT AND RIGHT SIDE TO BE EQUAL WITHIN 1.0°.
- D. TOE-IN LEFT AND RIGHT SIDE TO BE SET EQUALLY PER WHEEL AND STEERING WHEEL MUST BE HELD IN STRAIGHT AHEAD POSITION WITHIN ± 5.0°.

V2860

Figure 7—Four Wheel Drive (K-Model) Alignment Specifications

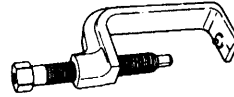
SPECIAL TOOLS

1.



J 38794

2.



J 36202

- 1. KNOCKOUT REMOVAL TOOL
- 2. TORSION BAR UNLOADING TOOL

V2862

3A-14 FRONT WHEEL ALIGNMENT

NOTES

SECTION 3B

POWER STEERING GEAR AND PUMP

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The hydraulic power steering system consists of a pump, fluid reservoir, steering gear, pressure hose, and a return hose.

POWER STEERING GEAR

The power steering gear has a recirculating ball system which acts as a rolling thread between the worm shaft and the rack piston. The worm shaft is supported by a preloaded thrust bearing and two conical thrust races at the lower end, and a bearing assembly in the adjuster plug at the upper end. When the worm shaft is

turned right, the rack piston moves up in the gear. Turning the worm shaft left moves the rack piston down in the gear. The rack piston teeth mesh with the sector, which is part of the pitman shaft. Turning the worm shaft turns the pitman shaft, which turns the wheels through the steering linkage.

The control valve in the steering gear directs the power steering fluid to either side of the rack piston. The rack piston converts the hydraulic pressure into a mechanical force. If the steering system becomes damaged and loses hydraulic pressure, the vehicle can be controlled manually.

3B-2 POWER STEERING GEAR AND PUMP

HYDRAULIC PUMP

The power steering pump is a vane-type design. The submerged pump (figure 1) has a housing and internal parts that are inside the reservoir and operate submerged in oil.

There are two bore openings at the rear of the pump housing. The larger opening contains the cam ring, pressure plate, thrust plate, rotor and vane assembly, and end plate. The smaller opening contains the pressure hose union, flow control valve, and spring. The flow control orifice is part of the pressure hose union. The pressure relief valve inside the flow control valve limits the pump pressure.

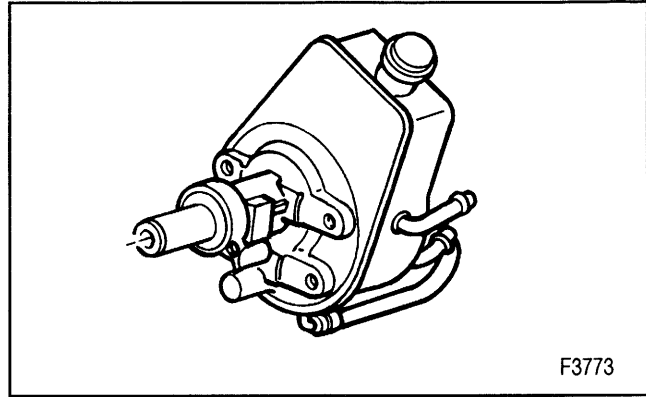


Figure 1—Power Steering Pump

DIAGNOSIS OF POWER STEERING SYSTEM

PROBLEM	POSSIBLE CAUSE	CORRECTION
Objectionable "Hiss"	Noisy relief valve in the hydraulic pump.	There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. Hiss is a high frequency noise. The noise is present in every valve and results from high velocity fluid passing valve orifice edges. There is no relationship between this noise and performance of the steering. "Hiss" may be expected when the steering wheel is at end of travel or when slowly turning at standstill. Do not replace valve unless "hiss" is extremely objectionable. A replacement valve will also exhibit slight noise and is not always a cure for the objection.
Rattle Or Chuckle Noise In Steering Gear	1. Gear loose on the frame. 2. Steering linkage looseness. 3. Pressure hose touching other parts of vehicle. 4. Loose pitman arm. 5. Improper over-center adjustment. A slight rattle may occur on turns because of increased clearance off the "high point." This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	1. Check the gear mounting bolts. Torque the bolts to specifications. 2. Check linkage pivot points for wear. Replace if necessary. 3. Adjust the hose position. Do not bend tubing by hand. 4. Torque the pitman arm bolt. 5. Adjust to specifications.
Excessive Wheel Kickback Or Loose Steering	1. Air in the system. 2. Steering gear mounting loose. 3. Steering linkage joints worn. 4. Front wheel bearings incorrectly adjusted or worn. 5. Steering gear improperly adjusted. 6. Damaged or worn steering gear.	1. Add oil to the pump reservoir and bleed. Check hose connectors for proper torque. 2. Tighten attaching bolts to specified torque. 3. Replace loose parts. 4. Adjust the bearings or replace with new parts as necessary. 5. Adjust to specifications. 6. Disassemble and repair the steering gear as outlined in the Light Duty Truck Unit Repair Manual.

DIAGNOSIS OF POWER STEERING SYSTEM (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vehicle Leads To One Side Or The Other	1. Keep in mind the road and wind conditions. 2. Front wheels misaligned. 3. Unbalanced steering gear valve. If this is the cause, steering effort will be very light in direction of lead and heavy in opposite direction. 4. Steering shaft rubbing the ID of the shaft tube.	1. Test the vehicle, going in both directions, on a flat road. 2. Adjust to specifications. 3. Replace the gear valve. 4. Align the column.
Momentary Increase In Effort When Turning The Wheel Quickly To The Right Or Left	1. Low oil level in the pump. 2. Pump belt slipping. 3. High internal leakage (steering gear or pump).	1. Add power steering fluid as required. 2. Refer to SECTION 6B1. 3. Refer to "Power Steering System Test" in this section.
Poor Return Of Steering	1. Tires under-inflated. 2. Lower coupling flange rubbing against the steering gear adjuster plug. 3. Steering wheel rubbing against directional signal housing. 4. Tight or frozen steering shaft bearings. 5. Binding of steering linkage, steering shock absorber or ball joints. 6. Steering gear to column misalignment. 7. Tie rod pivots not centralized. 8. Lack of lubricant in the suspension ball joints and the steering linkage. 9. Stuck or plugged valve spool. 10. Rubber spacer binding in the shift tube. 11. Improper front wheel alignment. 12. Steering gear adjusted too tightly. 13. Kink in return hose. 14. Steering intermediate shaft stone shield side-loaded against shaft assembly.	1. Inflate to specified pressure. 2. Loosen the pinch bolt and assemble properly. 3. Adjust the steering jacket. 4. Replace the bearings. 5. Replace the affected parts. 6. Align the steering column. 7. Adjust tie rod ends as required to center pivots. 8. Lubricate. Refer to SECTION 0B. 9. Remove and clean or replace the valve. 10. Make certain the spacer is properly seated. Lubricate inside the diameter with silicone lubricant. 11. Check and adjust to specifications. 12. Adjust over-center and thrust bearing preload to specifications. 13. Replace the hose. 14. Eliminate side-load.
Steering Wheel Surges Or Jerks When Turning With Engine Running Especially During Parking	1. Low oil level in pump. 2. Loose pump belt. 3. Sticky flow control valve. 4. Insufficient pump pressure. 5. Faulty gear relief valve.	1. Add power steering fluid as required. 2. Refer to SECTION 6B1. 3. Replace or clean the control valve. 4. Refer to "Power Steering System Test" in this section. 5. Replace the gear relief valve.

3B-4 POWER STEERING GEAR AND PUMP

DIAGNOSIS OF POWER STEERING SYSTEM (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hard Steering Effort in Both Directions	1. Low tire pressure. 2. Lack of lubricant in suspension or ball joints (Worn/contaminated joints). 3. Binding of steering linkage, steering shock absorber, or ball joints. 4. Steering gear to column misalignment. 5. Pump belt slipping. 6. Low fluid level in reservoir. 7. High internal leakage (steering gear or pump). 8. Sticky flow control valve. 9. Lower coupling flange rubbing against steering gear adjuster plug. 10. Steering gear adjusted too tight. 11. Improper front wheel alignment.	1. Adjust the tire pressure. 2. Lubricate and relubricate at proper intervals or replace joints. Refer to SECTION 0B. 3. Replace all affected parts. 4. Align the steering column. 5. Refer to SECTION 6B1. 6. Fill to proper level. Inspect lines and joints for external leakage. 7. Refer to "Power Steering System Test" in this section. 8. Replace or clean the valve. 9. Loosen the pinch bolt and assembly properly. 10. Adjust over-center and thrust bearing preload to specifications. 11. Check and adjust to specifications.
Foaming Milky Looking Power Steering Fluid, Low Level And Possible Low Pressure	1. Air in the fluid and loss of fluid due to internal pump leakage causing over-flow. 2. Hose or air leakage in reservoir line.	Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeration should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
Low Oil Pressure Due To Restriction In The Hose	1. Check for kinks in the hose. 2. Foreign object stuck in the hose.	1. Remove the kinks or replace the hose. 2. Remove the foreign object or replace the hose.
Low Oil Pressure Due To Steering Gear. Refer To "Power Steering System Test" In This Section	1. Pressure loss in cylinder due to worn piston ring or scored housing bore. 2. Leakage at the valve rings and valve body to the worm seal. 3. Leakage at the valve body or a loose fitting spool.	1. Disassemble the steering gear as outlined in the Light Duty Truck Unit Repair Manual. Inspect the ring and housing bore. Replace the affected parts. 2. Disassemble steering gear and replace seals. 3. Replace the valve.
Low Oil Pressure Due To Steering Pump. Refer To "Power Steering System Test" In This Section	1. Flow control valve stuck or inoperative. 2. Pressure plate not flat against the cam ring. 3. Extreme wear of cam ring. 4. Scored pressure plate, thrust plate, or rotor. 5. Vanes sticking in rotor slots. 6. Vanes not installed properly. 7. Air in oil. 8. Low oil level. 9. Pump belt slipping. 10. Damaged hoses or steering gear.	1. Replace or clean the valve. 2. Replace the pressure plate. 3. Replace and flush the system. 4. Replace parts. If rotor, replace with rotating group. Flush the system. 5. Free up by removing burrs, varnish, or dirt. 6. Install properly. Radius edge to the outside. 7. Locate source of leak and correct. Bleed the system. 8. Add power steering fluid as required. 9. Refer to SECTION 6B1. 10. Replace as necessary.
Chirp Noise In Steering Pump	Pump belt slipping.	Refer to SECTION 6B1.

DIAGNOSIS OF POWER STEERING SYSTEM (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Belt Squeal (Particularly Noticeable At Full Wheel Travel And Standstill Parking)	Pump belt slipping.	Refer to SECTION 6B1.
Growl Noise In Steering Pump	Excessive back pressure in hoses or steering gear caused by restriction.	Locate restriction and correct.
Growl Noise In Steering Pump (Particularly Noticeable At Standstill Parking)	1. Scored pressure plates, thrust plate, or rotor. 2. Extreme wear of cam ring.	1. Replace parts and flush system. 2. Replace parts.
Groan Noise In Steering Pump	1. Low oil level. 2. Air in the oil. Poor pressure hose connection.	1. Add power steering fluid as required. 2. Torque the connector. Bleed the system.
Rattle Or Knock Noise In Steering Pump	1. Loose pump pulley nut. 2. Pump vanes sticking in rotor slots. 3. Pressure hose touching other parts of vehicle.	1. Torque nut. 2. Free up by removing burrs, varnish, or dirt. 3. Adjust hose position.
Swish Noise In Steering Pump	Faulty flow control valve.	Replace part.
Whine Noise In Steering Pump	Pump shaft bearing scored.	Replace the housing and shaft. Flush the system.
D0004		

LOCATING OIL LEAKS

1. With the ignition "OFF," wipe the complete power steering system dry (gear, pump, hoses, and connections).
2. Check the oil level in the pump's reservoir and adjust as directed. Refer to "Fluid Level Adjustment."
3. Start the engine and turn the steering wheel from stop to stop several times. Do not hold the wheel against the stops as this may damage the pump.
4. Locate the exact area of the leak (figure 2).
 - A. Return Tube Fitting—Tighten hose clamp if loose. If the fitting is deformed, replace it. Apply Loctite 75559 solvent and Loctite 290 adhesive (or equivalent) to the tube-housing connection.
 - B. Pressure Hose Fitting—Tighten the fitting to 33 N.m (24 lbs. ft.). If leakage persists, replace the seal.
 - C. Ball Seat Leak—Seat the ball in the housing with a blunt punch. Following the manufacturer's directions, apply Loctite 75559 solvent and Loctite 290 adhesive (or equivalent) to the area.
 - D. Drive Shaft Seal—Replace the drive shaft seal. Make sure that the drive shaft is clean and free of pitting in the seal area.
 - E. Housing Plug Seal—Seat the plug in the housing. Following manufacturer's directions, apply Loctite 75559 solvent and Loctite 290 adhesive (or equivalent) to the plug-housing area.
 - F. Housing Seal—Replace the seal.

- G. Side Cover Leak—Tighten side cover bolts to 60 N.m (45 lbs. ft.). Replace the side cover seal if the leakage persists.
- H. Adjuster Plug Seal—Replace the adjuster plug seals.
- I. Pressure Hose Fitting—Tighten the hose fitting nut to 33 N.m (24 lbs. ft.). If leakage persists, replace the seal.
- J. Pitman Shaft Seals—Replace the seals.
- K. Top Cover Seal—Replace the seal.

POWER STEERING SYSTEM TEST

Tools Required:

- J 5176-D Power Steering Gage
- J 5421-02 Thermometer

The power steering system test is a method used to identify and isolate hydraulic circuit difficulties. Prior to performing this test, the following inspection and necessary corrections must be made (figure 3).



Inspect

- Pump reservoir for proper fluid level.
- Pump belt for proper tension. Refer to SECTION 6B1.
- Pump drive pulley condition. Refer to SECTION 6B1.

3B-6 POWER STEERING GEAR AND PUMP

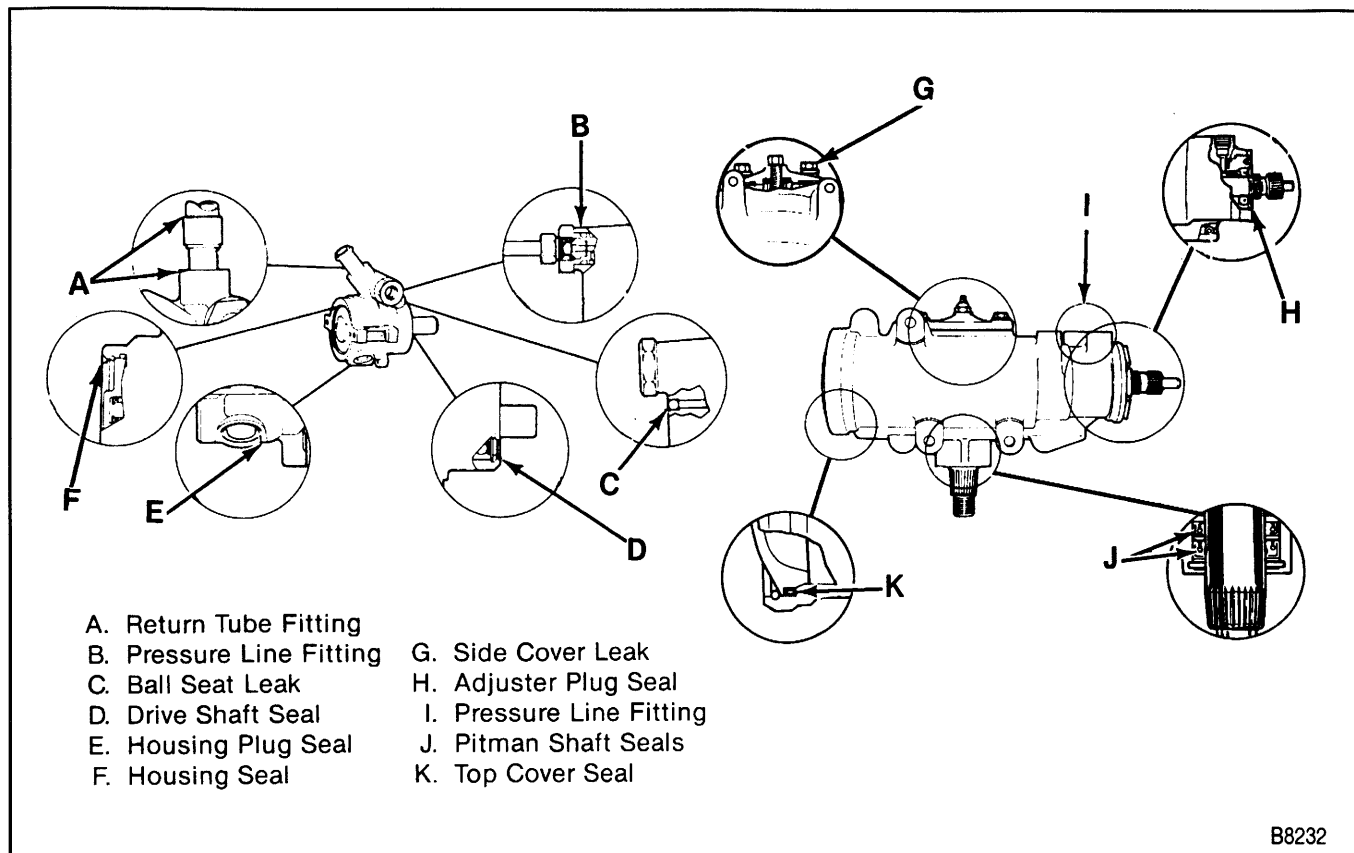


Figure 2—Fluid Leak Locations

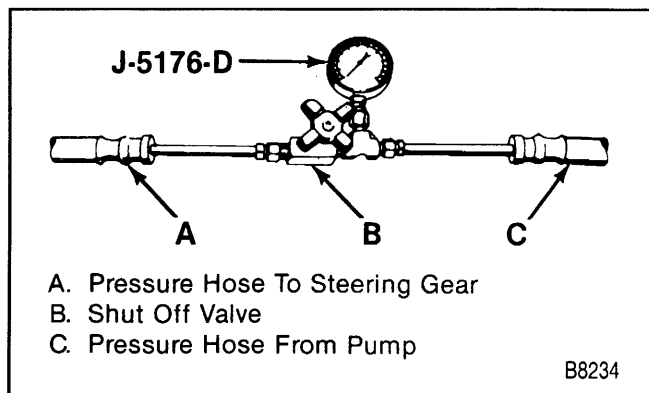


Figure 3—Checking Power Steering Pressure

! Important

- All tests are made with the engine idling at normal operating temperature.
1. Place a container under the steering gear or pump to catch the fluid when disconnecting or connecting the hoses.
 2. With the ignition "OFF," disconnect the pressure hose at the steering gear or power steering pump and install J 5176-D to both hoses. The gage must be between the shutoff valve and pump. Open the shutoff valve.

! Important

- To prevent scrubbing flat spots on the tires, do not turn the steering wheel more than five times without rolling the vehicle to change the tire-to-floor contact area.
6. Start the engine and check the pump's fluid level. Add power steering fluid if required. When the engine is at normal operating temperature, the initial pressure reading on the gage (valve open) should be in the 550-860 kPa (80-125 psi) range. Should this pressure be in excess of 1380 kPa (200 psi), check the hoses for restrictions and the poppet valve for proper assembly.

NOTICE: Do not leave valve fully closed for more than 5 seconds, since this could damage the pump internally.

7. Fully close the gate valve three times. Record the highest pressures attained each time.
 - If the pressures recorded are within 9,308-9,998 kPa (1350-1450 psi), C3HD 10,101-10,446 kPa (1,465-1,515) and the range of readings within 345 kPa (50 psi), the pump is functioning within its specifications.
 - If the pressures recorded are high, but do not repeat within 345 kPa (50 psi), the flow controlling valve is sticking. Remove the valve, clean it and remove any burrs using crocus cloth or fine hone. If the system contains some dirt, flush it. If it is exceptionally dirty, both the pump and gear must be completely disassembled, cleaned, flushed, and reassembled before further usage.

- If the pressures recorded are constant but between 690 kPa (100 psi) and 9,308 kPa (1350 psi), replace the flow control valve and recheck. If the pressures are still low, replace the rotating group in the pump.
8. If the pump pressures are within specifications, leave the valve open and turn the steering wheel to both stops. Record the highest pressures and compare with the maximum pump pressure recorded. If this pressure cannot be reached in at least one side of the gear, the gear is leaking internally and must be disassembled and repaired.
 9. Shut the engine off, remove the testing gage, reconnect the pressure hose, check the fluid, level and/or make the needed repairs.
 10. If the problem still exists, the steering and front suspension must be thoroughly examined. Refer to "Diagnosis of Power Steering System."

ON-VEHICLE SERVICE

MAINTENANCE

Keep the power steering system clean. The pump steering fluid level should be checked at regular intervals and fluid added when required. Refer to SECTION 0B for type of fluid to be used and intervals for filling.

If the system contains some dirt, flush it as detailed later in this section. If it is exceptionally dirty, both the pump and the gear must be completely disassembled before further usage.

All tubes, hoses, and fittings should be inspected for leakage at regular intervals. Fittings must be tight. Make sure the clips, clamps, and supporting tubes and hoses are in place and properly secured.

Inspect the hoses with the wheels in the straight-ahead position. Then turn the wheels fully to the left and right while observing the movement of the hoses. Correct any hose contact with other parts of the vehicle that could cause chafing or wear.

Power steering hoses and pipes must not be twisted, kinked, or tightly bent. The hoses should have sufficient natural curvature in the routing to absorb movement and hose shortening during vehicle operation.

Air in the system will cause spongy action and noisy operation. When a hose is disconnected or when fluid is lost for any reason, the system must be bled after refilling. Refer to "Bleeding the Power Steering System."

FLUID LEVEL

1. Run the engine until the power steering fluid reaches normal operating temperature, about 80° C (170° F), then shut the engine off.
2. Remove the reservoir cap and check the fluid level on the dipstick. The fluid level should be about 12.7 to 25.4 mm (1/2 to 1 inch) from the top when the wheels are in full left turn position.

3. If the fluid level is low, add power steering fluid as specified in SECTION 0B to the proper level and install the reservoir cap.
4. When checking the fluid level after the steering system has been serviced, air must be bled from the system. Refer to "Bleeding the Power Steering System."

BLEEDING THE POWER STEERING SYSTEM

When a power steering pump or gear has been installed, or a power steering hose has been disconnected, the air that has entered the system must be bled out before the vehicle is operated. If air is allowed to remain in the power steering fluid system, noisy and unsatisfactory operation of the system may result.

- When bleeding the system, and any time fluid is added to the power steering system, be sure to use only power steering fluid as specified in SECTION 0B.
1. Fill the pump fluid reservoir to the proper level and let the fluid settle for at least 2 minutes.
 2. Start the engine and let it run for a few seconds. Do not turn the steering wheel. Then turn the engine off.
 3. Add fluid if necessary.
 4. Repeat the above procedure until the fluid level remains constant after running the engine.
 5. Raise the front end of the vehicle so that the wheels are off the ground.
 6. Start the engine. Slowly turn the steering wheel right and left, lightly contacting the wheel stops.
 7. Add power steering fluid if necessary.
 8. Lower the vehicle and turn the steering wheel slowly from lock to lock.
 9. Stop the engine. Check the fluid level and refill as required.
 10. If the fluid is extremely foamy, allow the vehicle to stand a few minutes. Then repeat the above procedure.

3B-8 POWER STEERING GEAR AND PUMP



Inspect

- Belt for tightness.
- Pulley for looseness or damage. The pulley should not wobble with the engine running.
- Hoses so they are not touching any other parts of the vehicle.
- Fluid level and fill to the proper level.

FLUSHING THE POWER STEERING SYSTEM

1. Raise the front end of the vehicle off the ground until the wheels are free to turn.
2. Remove the fluid return hose at the pump inlet connector and plug the connector port on the pump. Position the hose toward a large container to catch the draining fluid.
3. While an assistant is filling the reservoir with new power steering fluid, run the engine at idle. Turn the steering wheel from stop to stop. **DO NOT** contact wheel stops or hold the wheel in a corner or fluid will stop and the pump will be in pressure

relief mode. A sudden overflow from the reservoir may develop if the wheel is held at a stop.

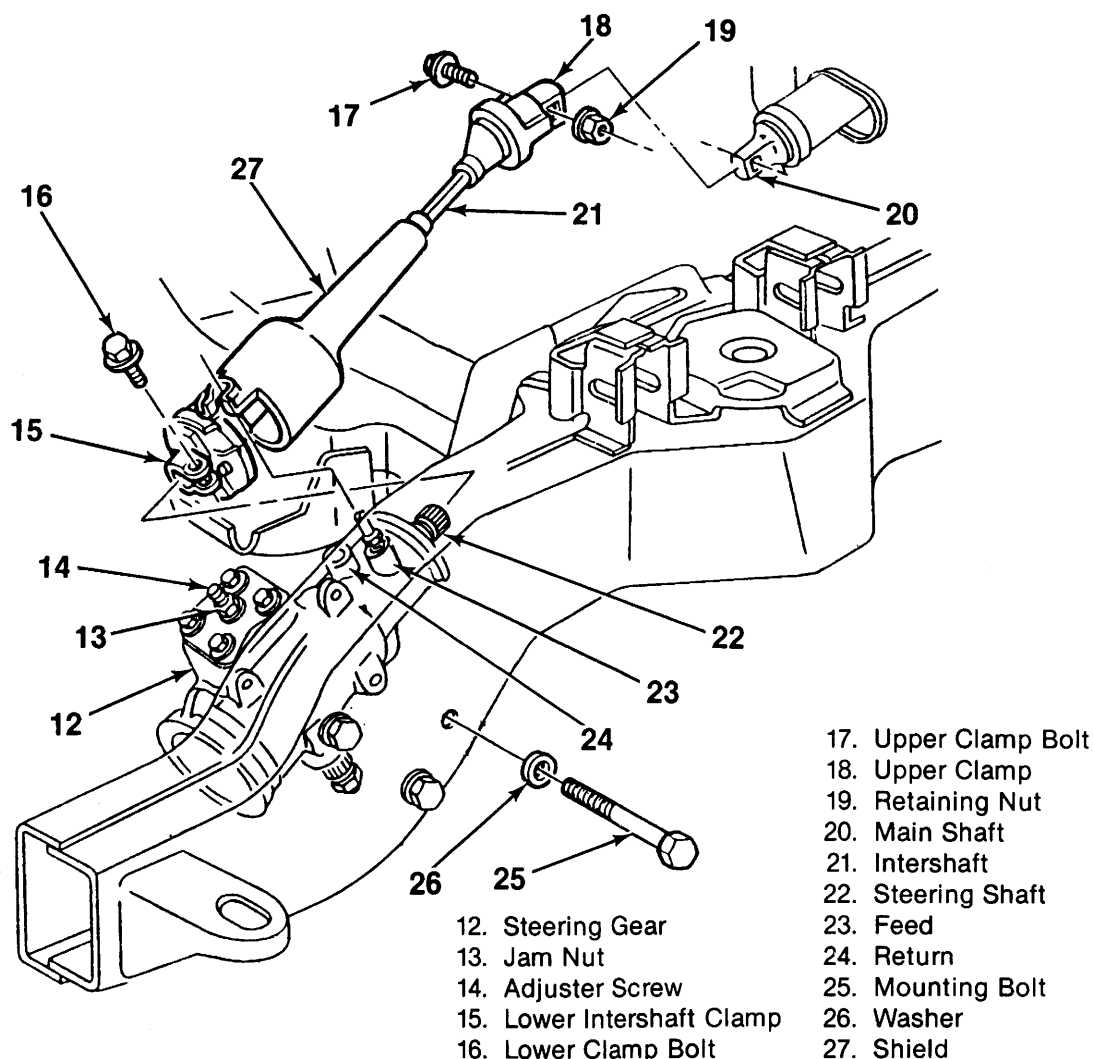
4. Install all the pipes and hoses. Fill the system with new power steering fluid and bleed the system as described in "Bleeding The Power Steering System." Operate the engine for about 15 minutes. Remove the pump return hose at the pump inlet and plug the connection on the pump. While refilling the reservoir, check the draining fluid for contamination. If foreign material is still evident, replace all hoses. Disassemble and clean or replace the power steering system components. Do not re-use any drained power steering fluid.

STEERING GEAR REPLACEMENT



Remove or Disconnect (Figure 4)

- Place a drain pan below the steering gear.
- 1. Hoses from the steering gear.
 - Cap or tape the ends of the hoses and gear fittings to prevent the entrance of dirt.



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Figure 4—Steering Gear Assembly

2. Shield (27).
3. Lower clamp bolt (16).
 - Draw alignment marks on the clamp (15) and the steering shaft (22) before removing the clamp.
4. Clamp (15) from the steering shaft (22).
5. Pitman arm. Refer to SECTION 3B1.
6. Bolts (25) and washers (26).
7. Steering gear (12).

Install or Connect (Figure 4)

NOTICE: For steps 2 and 5, refer to "Notice" on page 3B1-1.

1. Steering gear (12).
2. Washers (26) and bolts (25).

Tighten

- Bolts (25) to 135 N.m (100 lbs. ft.).
3. Pitman arm. Refer to SECTION 3B3.
 4. Clamp (15) to the steering shaft.
 - Make sure the alignment marks line up.
 5. Clamp bolt (16).

Tighten

- Bolt to 30 N.m (22 lbs. ft.).
6. Hoses (50 and 51) (figure 20).
- ## Tighten
- Hose coupling to 28 N.m (20 lbs. ft.).
7. Bleed the system. Refer to "Bleeding the Power Steering System."

PITMAN SHAFT SEAL REPLACEMENT

TWO WHEEL DRIVE (C-MODELS)

Remove or Disconnect (Figure 5)

Tool Required:
J 4245 Internal Snap Ring Pliers

- Mark the position of the pitman arm to the pitman shaft.
1. Pitman arm. Refer to SECTION 3B3.
 2. Dust seal.
 3. Snap ring (10) using J 4245.
 - Position a drain pan under the steering gear.
 - Start the engine.
 - Turn the steering wheel from stop to stop bouncing the wheel off the stops.
 - Stop the engine.
 4. Washer (7).
 5. Seals (6 and 8).

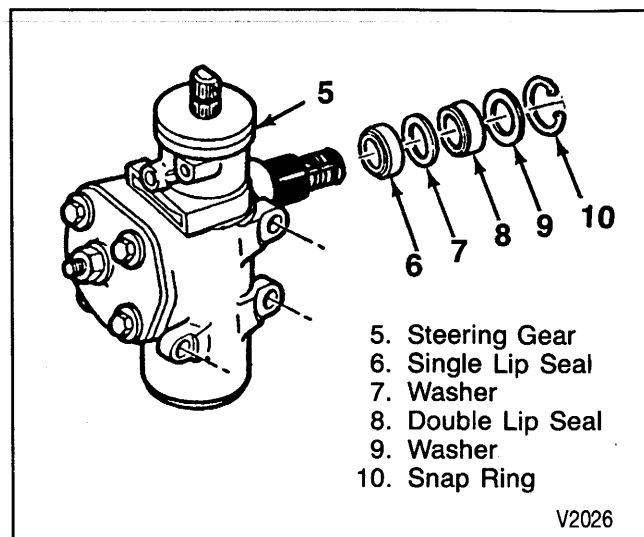


Figure 5—Pitman Seal Assembly

Inspect

- Pitman shaft seal surfaces for roughness or pitting. If pitted, replace the shaft.
- Housing for burrs. Remove the burrs before installing the new seals.

Clean

- Pitman shaft and seal areas using a crocus cloth.

Install or Connect (Figure 5)

Tools Required:

J 4245 Internal Snap Ring Pliers
J 6219 Seal Installer

- Lubricate the new seals with power steering fluid.
 - Apply a single layer of tape to the pitman arm shaft to avoid damaging the seals.
1. Seals (6 and 8).
 2. Washer (7) using J 6219 to seat the seals.
 - The seals should be in far enough to install the snap ring.
 3. Snap ring (10).
 4. Center the steering gear.
 - Turn the wheel until it stops.
 - Turn the wheel in the opposite direction until it stops, while counting the number of turns.
 - Turn the wheel back 1/2 the number of turns in the previous step.
 5. Dust seal.
 6. Pitman arm. Refer to SECTION 3B3.
 7. Bleed the system. Refer to "Bleeding the Power Steering System."

FOUR WHEEL DRIVE (K-MODELS)

Tools Required:
J 4245 Internal Snap Ring Pliers

Remove or Disconnect (Figures 4 and 5)

1. Power steering gear. Refer to Power Steering Gear Replacement.

3B-10 POWER STEERING GEAR AND PUMP

2. Pitman arm. Refer to SECTION 3B3.
3. Snap ring (10) using J 4245.
4. Pitman shaft seal. Refer to SECTION 3B1A.

Install or Connect (Figures 4 and 5)

1. Pitman shaft seal. Refer to SECTION 3B1A.
2. Snap ring (10) using J 4245.
3. Pitman arm. Refer to SECTION 3B3.
4. Power steering gear. Refer to Power Steering Gear Replacement.

STEERING GEAR ADJUSTMENT

Steering gear adjustments are made only as corrections and not as periodic adjustments. Before any adjustments are made, refer to "Diagnosis of Power Steering System" to review the possible steering system problems.

Adjusting the steering gear in the vehicle is NOT recommended. The gear should be removed from the vehicle and mounted in a vise.

The steering gear requires two adjustments, the worm thrust bearing preload and the pitman shaft over-center preload adjustment. The worm thrust bearing preload must be adjusted first, followed by the pitman shaft over-center preload adjustment.

WORM BEARING PRELOAD ADJUSTMENT

Tool Required:

J 7624 Adjustable Spanner Wrench

1. Remove the adjuster plug nut (figure 6).
 - To aid in the removal use a hammer and a brass punch.

NOTICE: Refer to "Notice" on page 3B-1.

2. Turn the adjuster plug in, using J 7624.
 - The plug and thrust bearing must be firmly bottomed in the housing.

Tighten

- Adjuster plug to 27 N.m (20 lbs. ft.).
3. Place an index mark on the housing even with one of the holes in the adjuster plug (figure 7).

4. Measure back (counterclockwise) 13 mm (0.50 inch) from the index mark and put a second mark on the housing (figure 8).
5. Rotate the adjuster plug back (counterclockwise) until the hole in the plug is aligned with the second mark on the housing (figure 9).
6. Install the adjuster plug nut.

- Be sure the adjuster plug does not turn while tightening the nut.

OVER CENTER PRELOAD ADJUSTMENT

1. Rotate the stub shaft from stop to stop and count the number of turns.
2. Starting at either stop, turn the stub shaft back 1/2 the total number of turns. This is the "center" of the gear.

- When the gear is centered, the flat on the stub shaft should face upward and be parallel with the side cover (figure 10). The master spline on the pitman shaft should be in line with the adjuster screw (C) (figure 11).

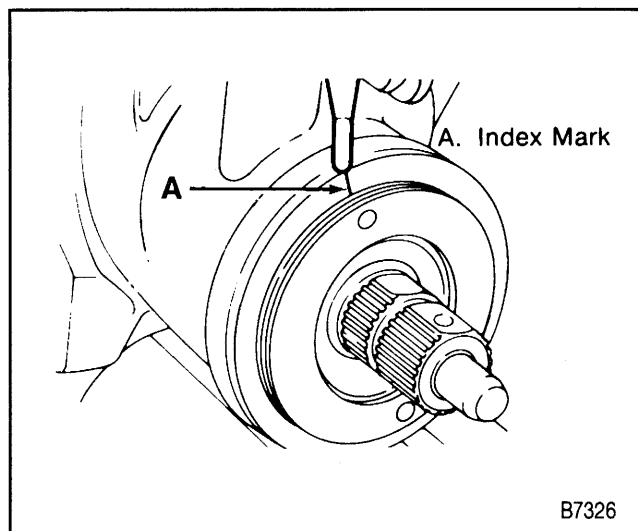


Figure 7—Alignment Marking the Adjuster Plug Hole with the Housing

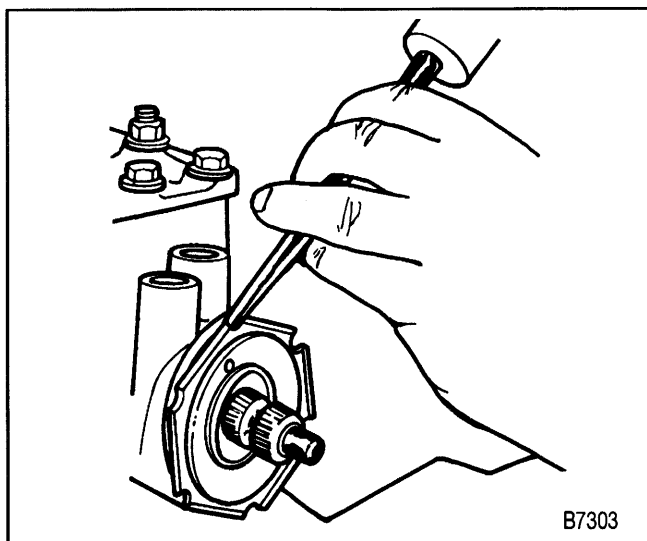


Figure 6—Loosening the Adjuster Plug Nut

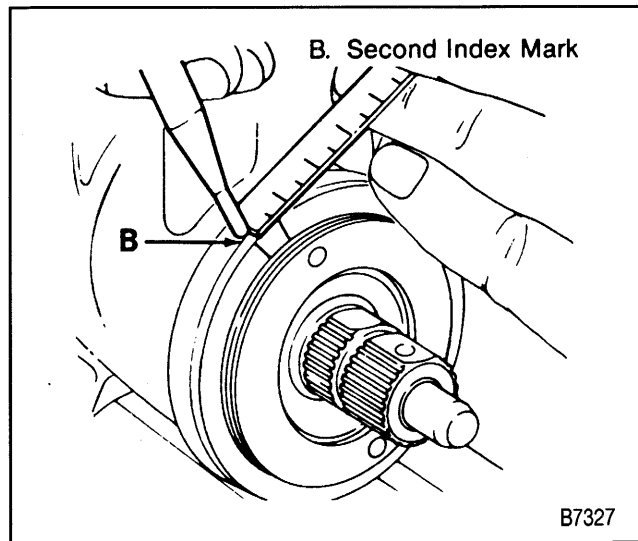


Figure 8—Remarking the Housing

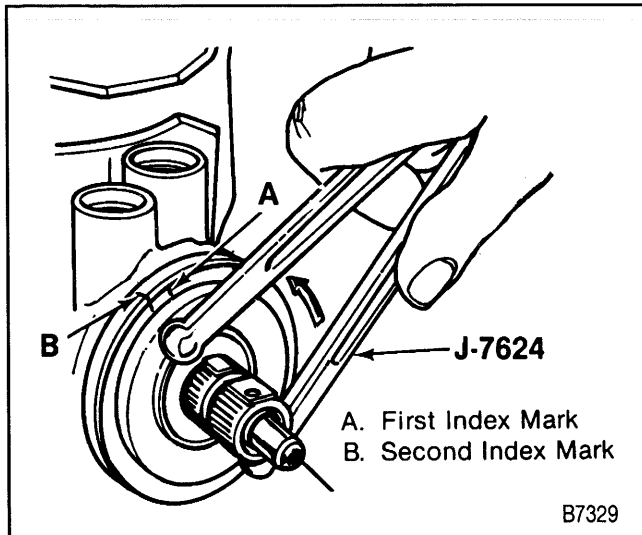


Figure 9—Aligning the Adjuster to the Second Mark

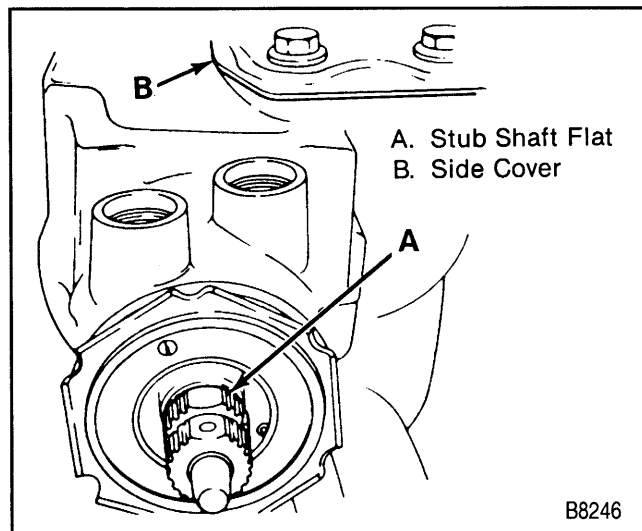


Figure 10—Aligning the Stub Shaft

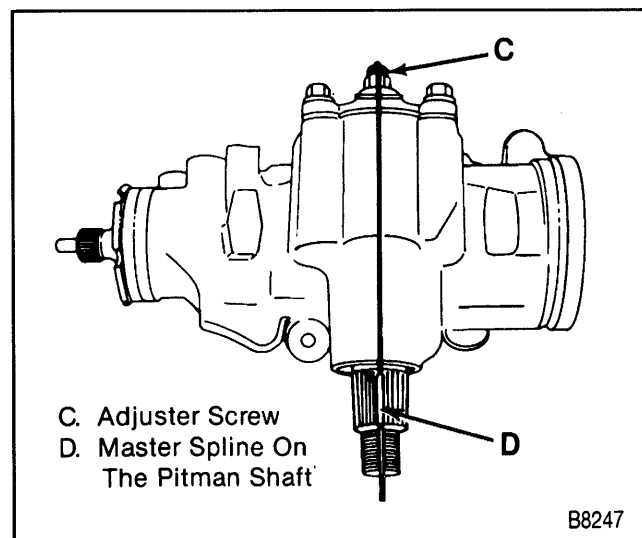


Figure 11—Aligning the Pitman Shaft Master Spline

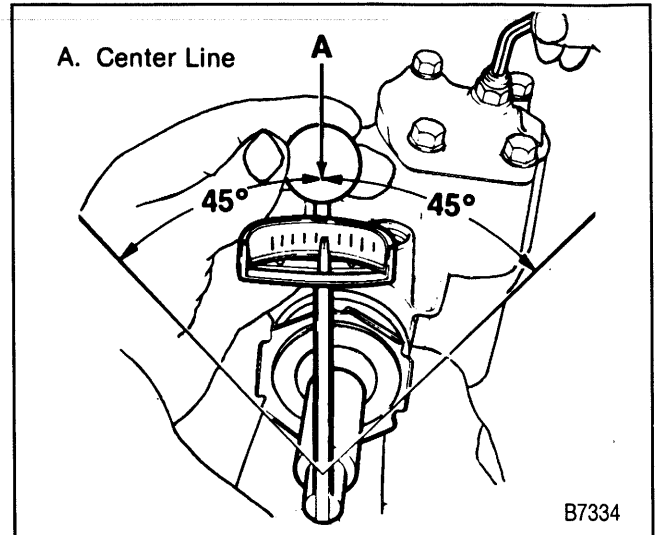


Figure 12—Checking Over-Center Rotational Torque

3. Turn the pitman shaft adjuster screw counterclockwise until fully extended, then turn back in one full turn.
4. Place the torque wrench, in the vertical position, on the stub shaft. Rotate the torque wrench 45 degrees each side of the center and record the highest drag torque measured on or near center (figure 12).
5. Turn the adjuster in until the torque required to turn the stub shaft is 0.6 to 1.2 N·m (6.0 to 10.0 in. lbs.) greater than the reading in step 4.

NOTICE: Refer to "Notice" on page 3B-1.



Tighten

- Adjuster jam nut to 44 N·m (32 lbs. ft.).

POWER STEERING PUMP REPLACEMENT



Remove or Disconnect (Figures 13 through 17)

Tool Required:

J 25034-B Puller

- Place a drain pan below the pump.

1. Hoses. Cap the hoses.
2. Unload the tensioner assembly. Refer to SECTION 6B1.
3. Belt.
4. Pulley (35).
 - Install J 25034-B. Be sure the pilot bolt bottoms in the pump shaft by turning the nut to the top of the pilot bolt (figure 13, A).
 - Hold the pilot bolt.
 - Turn the nut counterclockwise.
5. Front mounting bolts (36) (4.3L, 5.0L, and 5.7L engines).
6. Rear brace (38) (7.4L engines).
7. Front brace (38) and rear mounting nuts (43) (6.5L diesel engines).
8. Pump (33).

3B-12 POWER STEERING GEAR AND PUMP

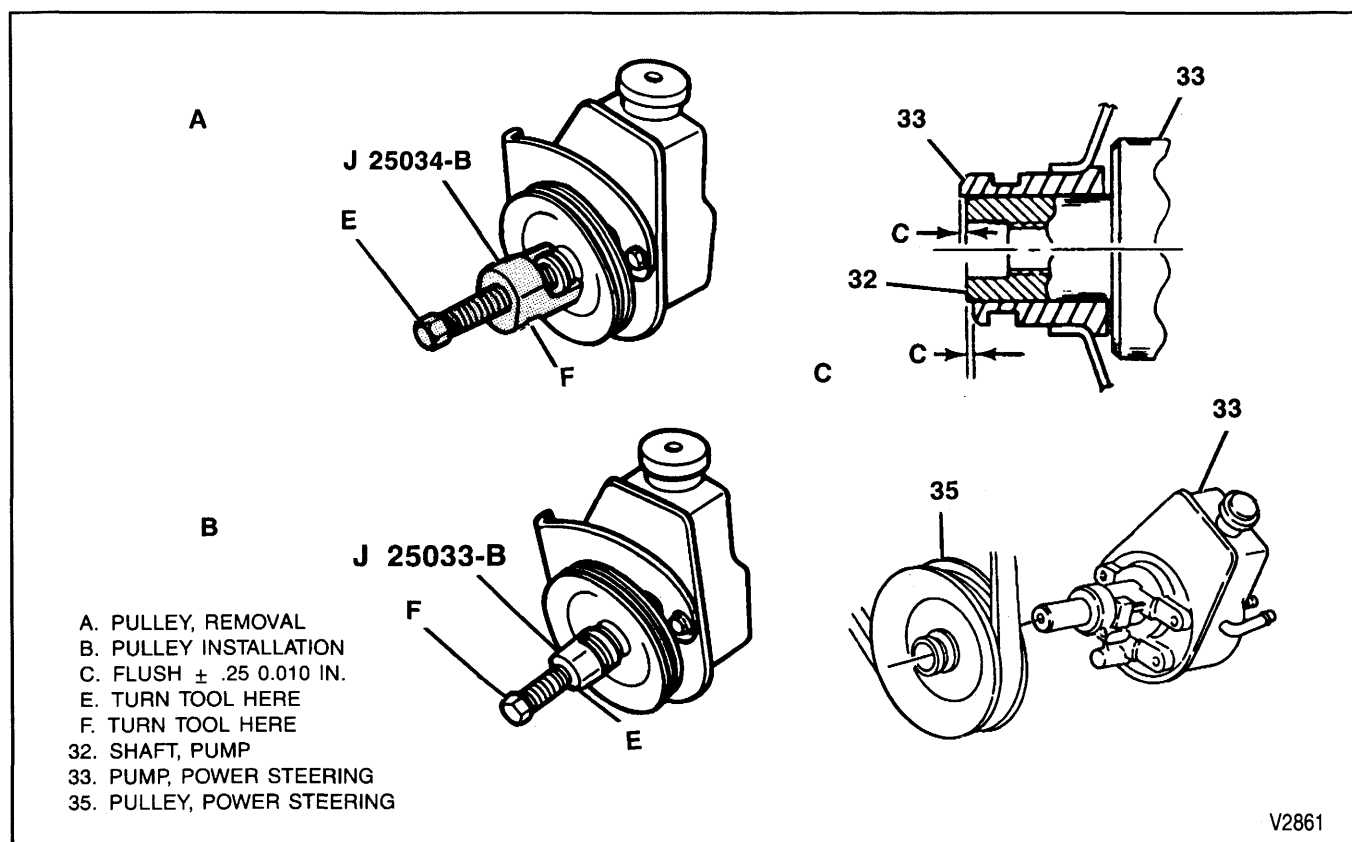


Figure 13—Replacing Steering Pump Pulley

Install or Connect (Figures 13 through 16)

Tool Required:
J 25033-B Pulley Installer

NOTICE: For steps 2 through 6, refer to "Notice" on page 3B1-1.

1. Pump (33).
2. Mounting bolts (36) (4.3L, 5.0L, 5.7L engines).

Tighten

- Bolts to 50 N.m (37 lbs. ft.).

3. Mounting bolts (36) (7.4L engines).

Tighten

- Bolts to 50 N.m (37 lbs. ft.).

4. Brace (38) (4.3L, 5.0L, 5.7L, 7.4L engines).

Tighten

- Nut (40) to 50 N.m (37 lbs. ft.).
- Bolt to 33 N.m (24 lbs. ft.).

5. Rear mounting nuts (43) (6.5L diesel engine).

Tighten

- Nuts to 50 N.m (37 lbs. ft.).

6. Front brace (38) (6.5L diesel engine).

Tighten

- Bolts to 40 N.m (30 lbs. ft.).
- Nut to 40 N.m (30 lbs. ft.).

7. Pulley.

- Place pulley on the end of the pump shaft.
- Install J 25033-B. Be sure the pilot bolt bottoms in the shaft by turning the nut to the top of the pilot bolt (figure 13, B).
- Hold the pilot bolt.
- Turn the nut clockwise.
- Install pulley flush ± 0.25 mm (0.010 in.) with the end of the power steering pump shaft (figure 13, C).

NOTICE: Do not use arbor press or internal damage to the pump will result.

8. Belt.

9. Load the tensioner assembly. Refer to SECTION 6B1.

10. Hoses.

- Fill and bleed the system. Refer to "Bleeding the Power Steering System."

Inspect

- Hoses for clearance.

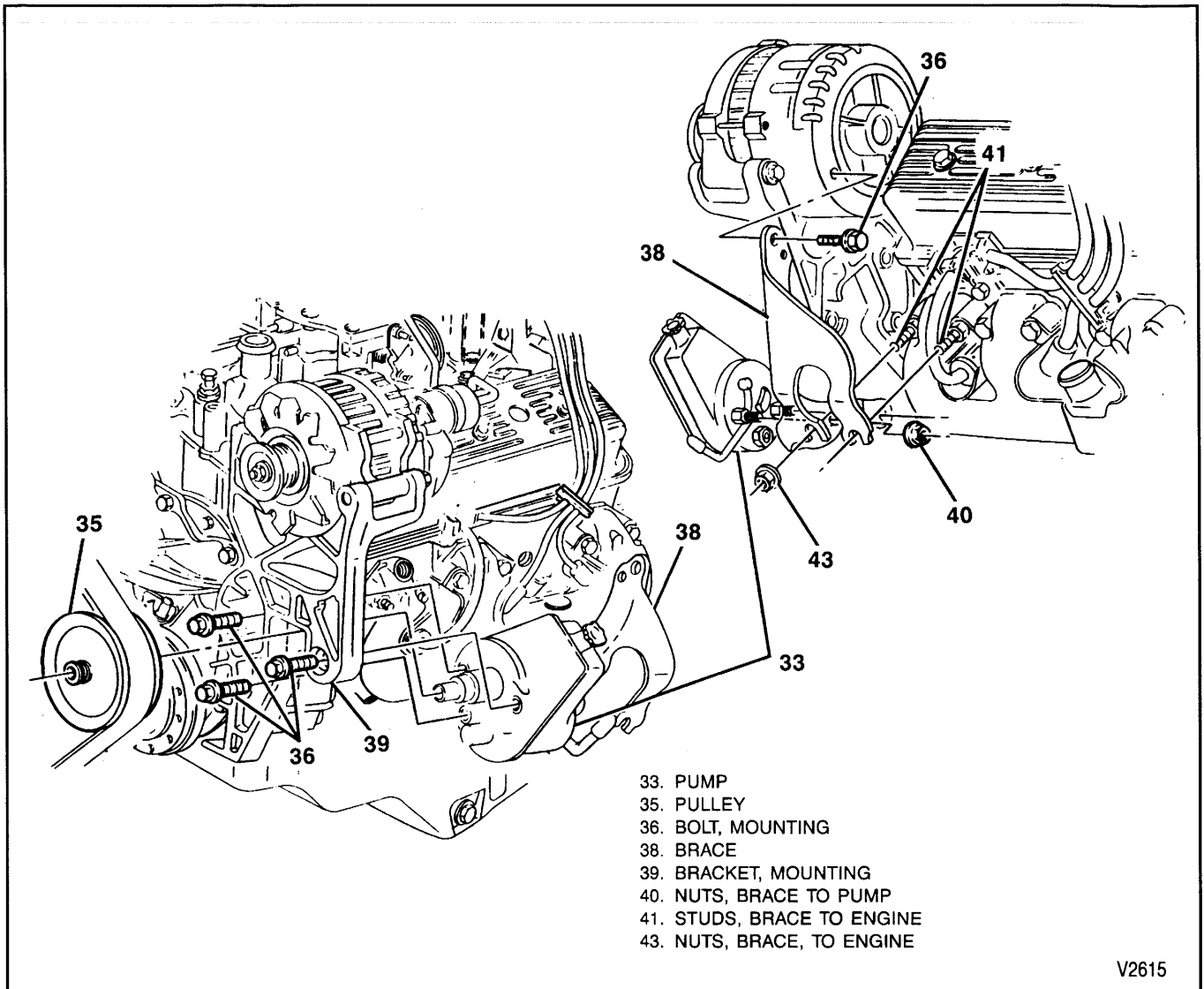


Figure 14—Power Steering Pump Mounting (4.3L, 5.0L, 5.7L Engines)

3B-14 POWER STEERING GEAR AND PUMP

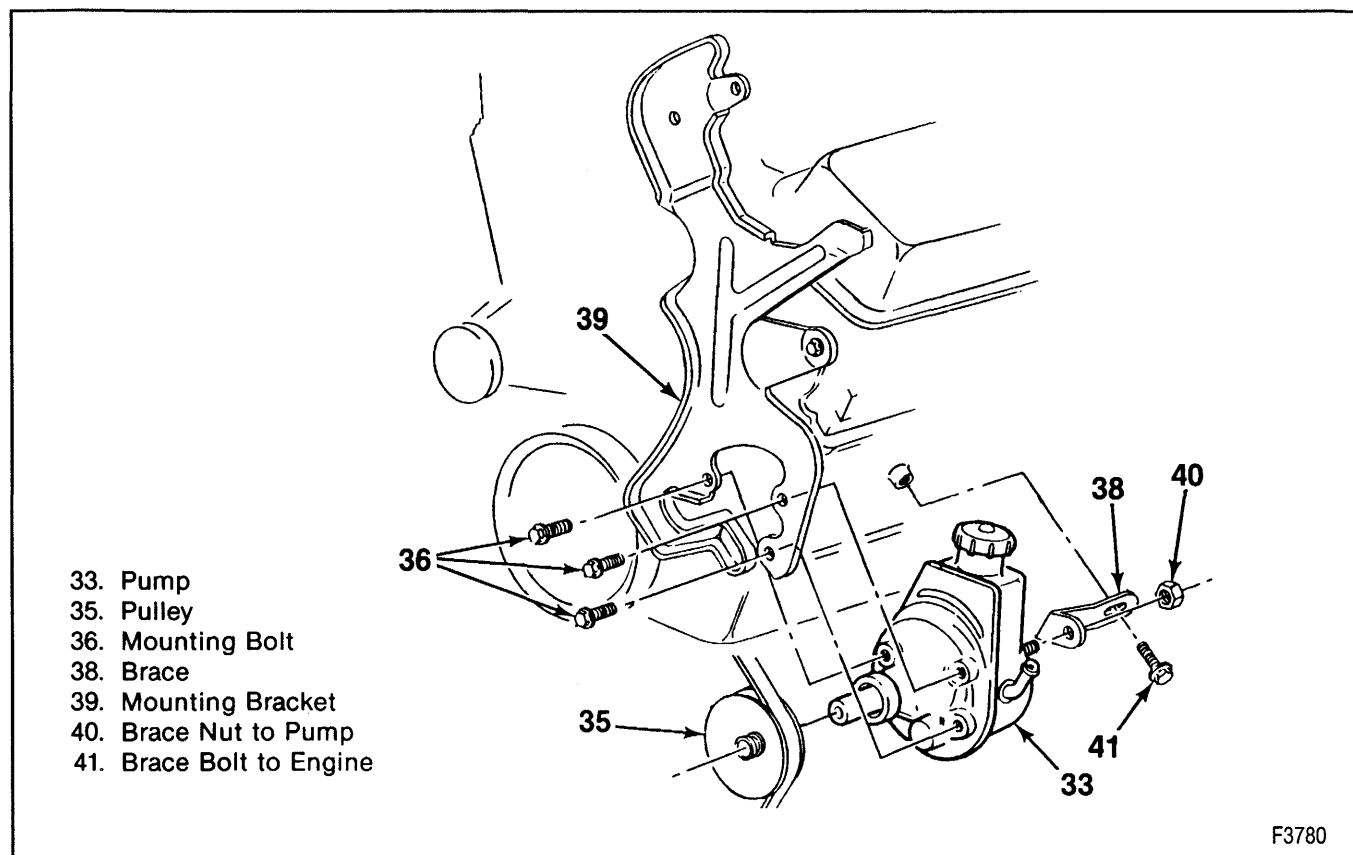


Figure 15—Power Steering Pump Mounting (7.4L Engines)

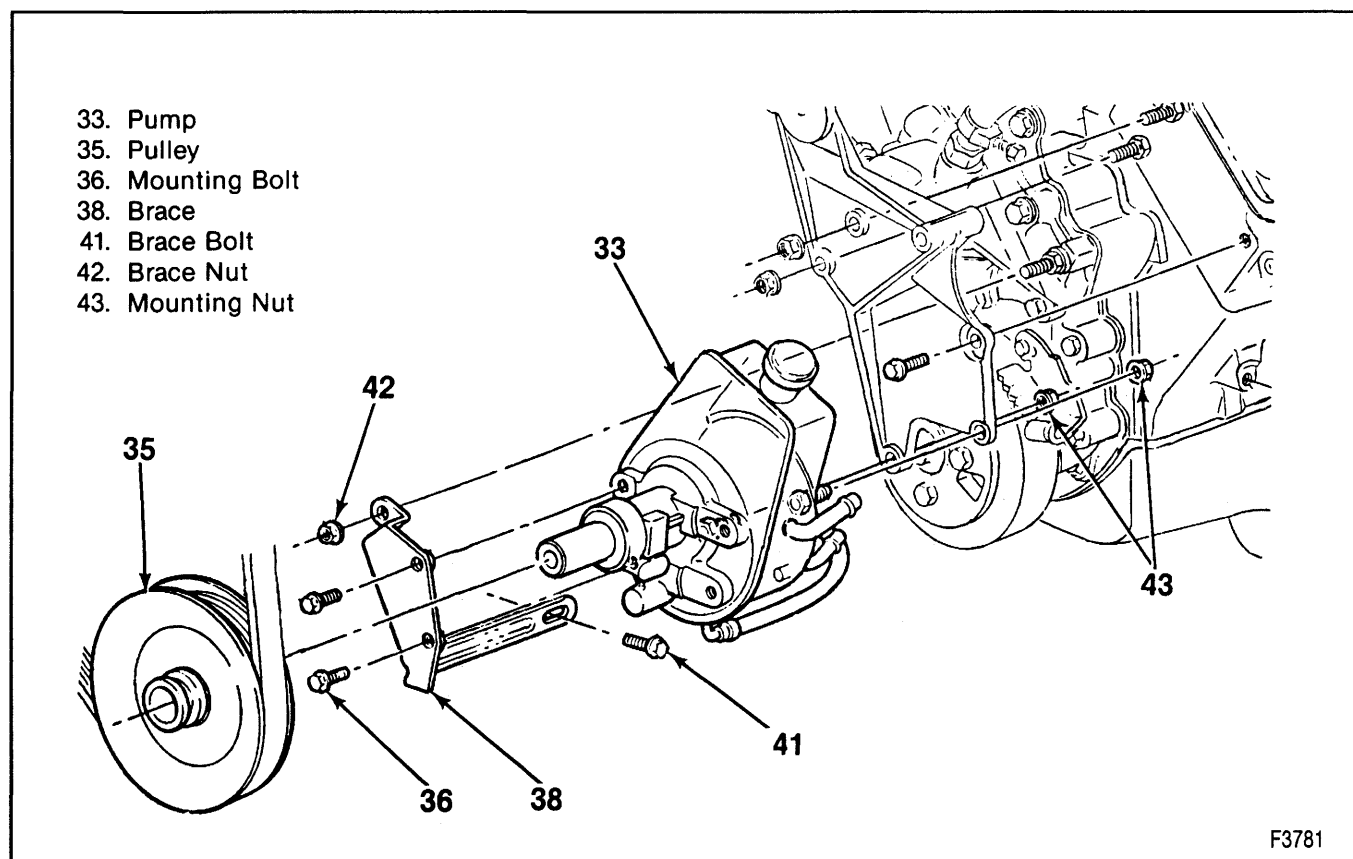


Figure 16—Power Steering Pump Mounting (6.5L Diesel Engines)

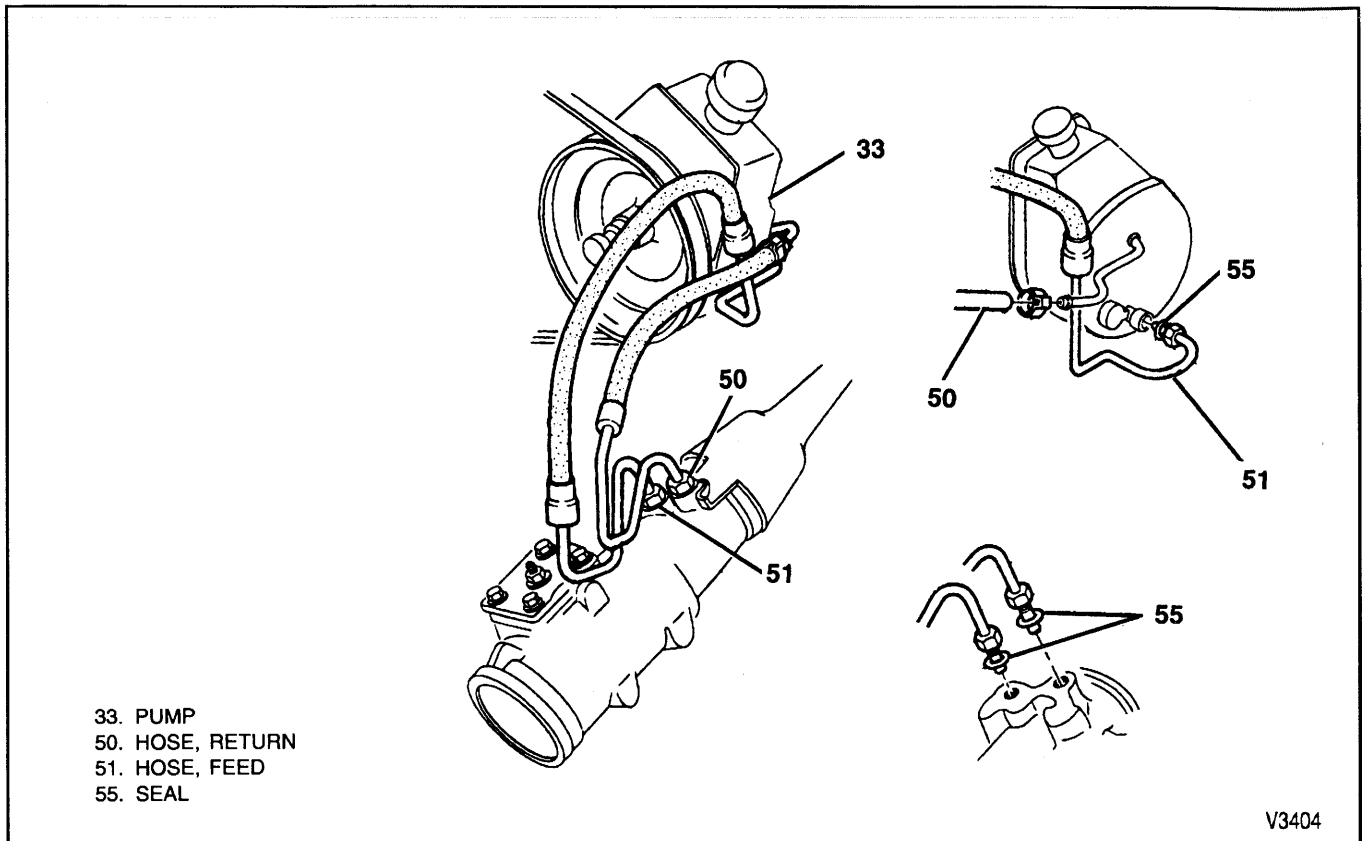


Figure 17—Hose Routing (C1,2 with 4.3L, 5.0L and 5.7L Engines—K1 with 5.7L Engine)

POWER STEERING HOSES

When a hose is reinstalled or replaced, the following points are essential:

- Route hoses in the same position they were in before removal (figures 17 to 21).
- Route hoses smoothly; avoid sharp bends and kinking.

- After hoses are installed, check for leaks while the system is being bled. Refer to "Bleeding the Power Steering System."
- Torque the hose connections to 28 N.m (20 lbs. ft.).

NOTICE: Do not start the engine with any power steering hose disconnected, or damage to the components could occur.

3B-16 POWER STEERING GEAR AND PUMP

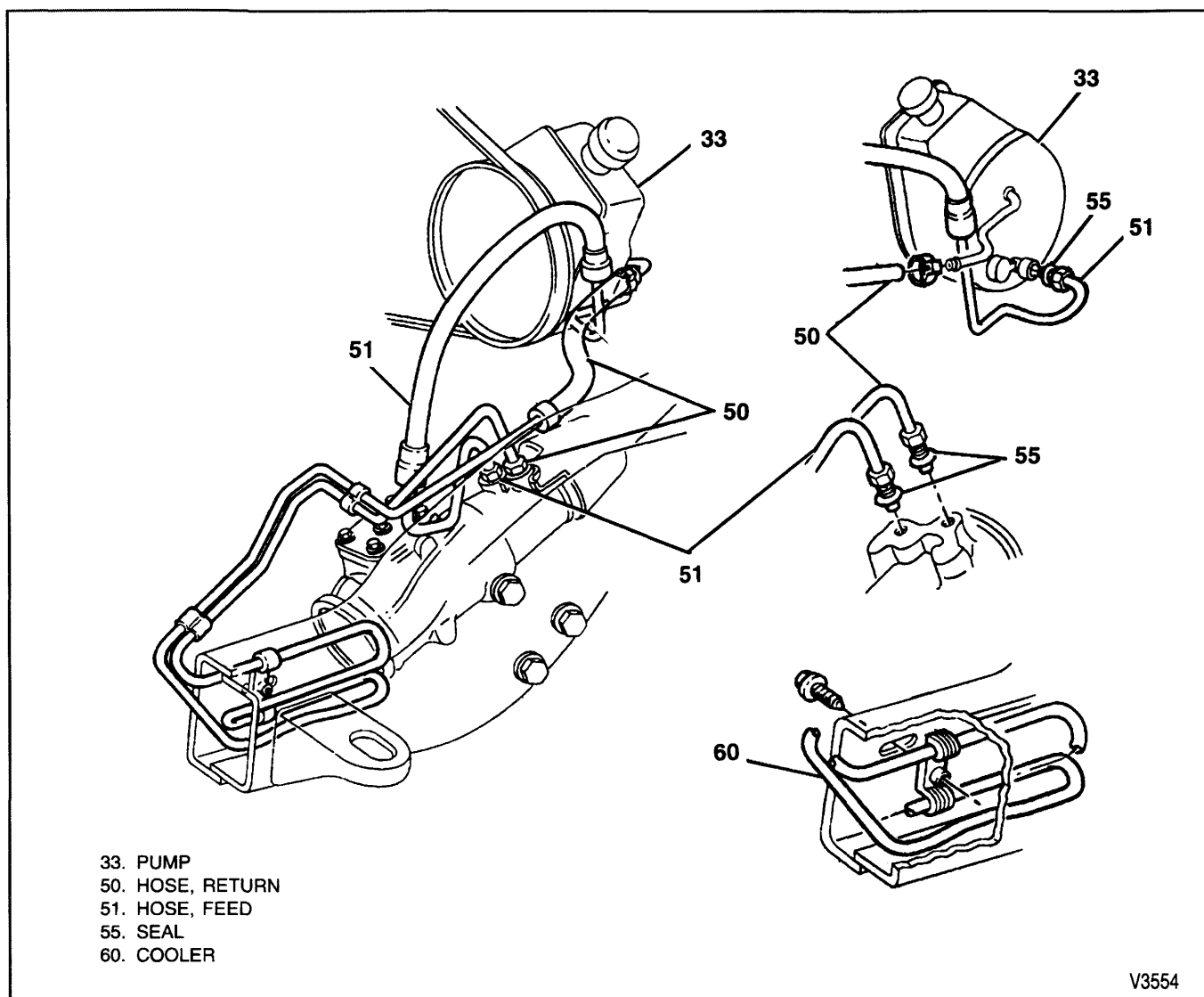


Figure 18—Hose Routing (CK1, 2, 3 with 4.3L, 5.0L, 5.7L and 7.4L Engines)

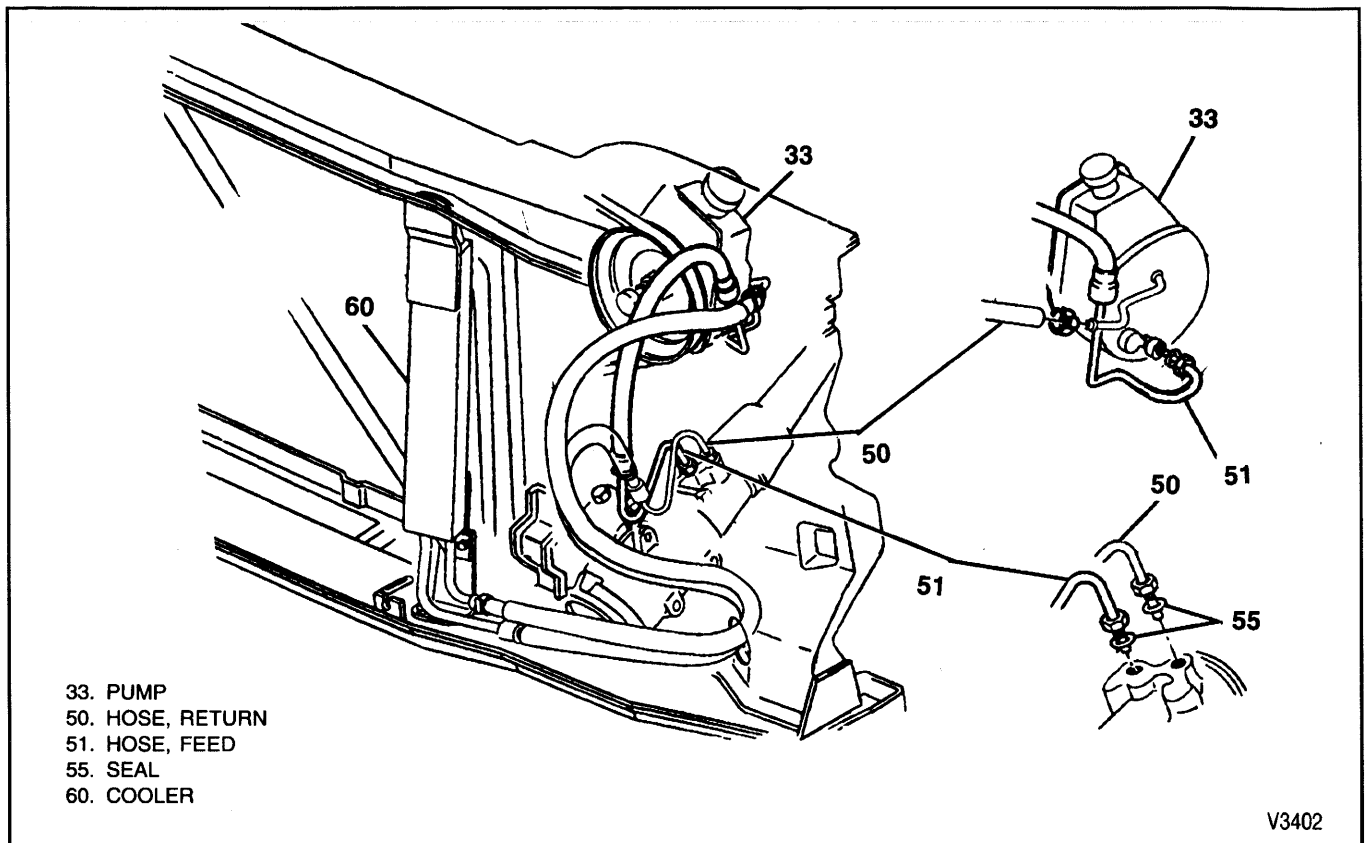


Figure 19—Hose Routing (K1,2 with 4.3L Engine)

3B-18 POWER STEERING GEAR AND PUMP

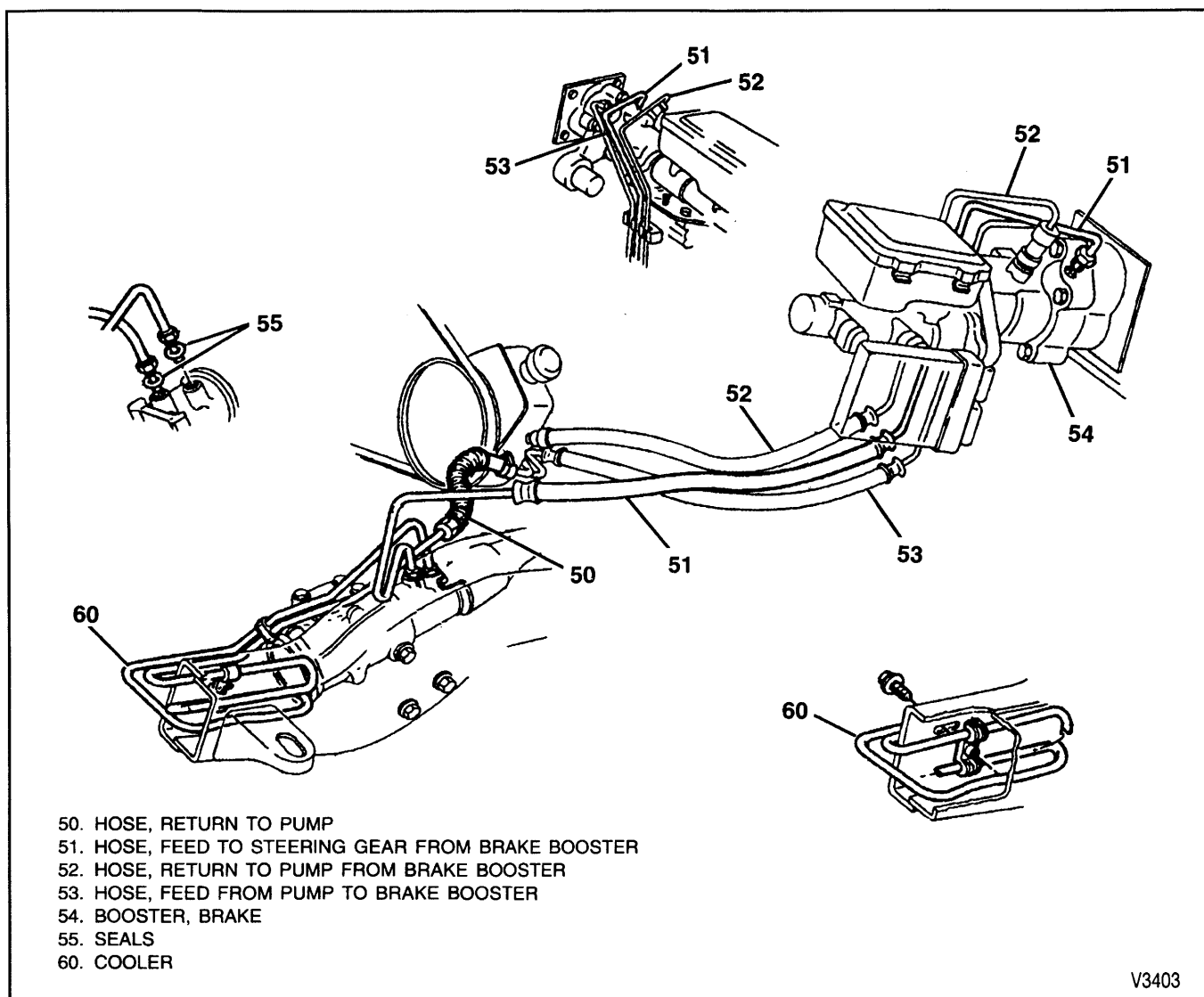
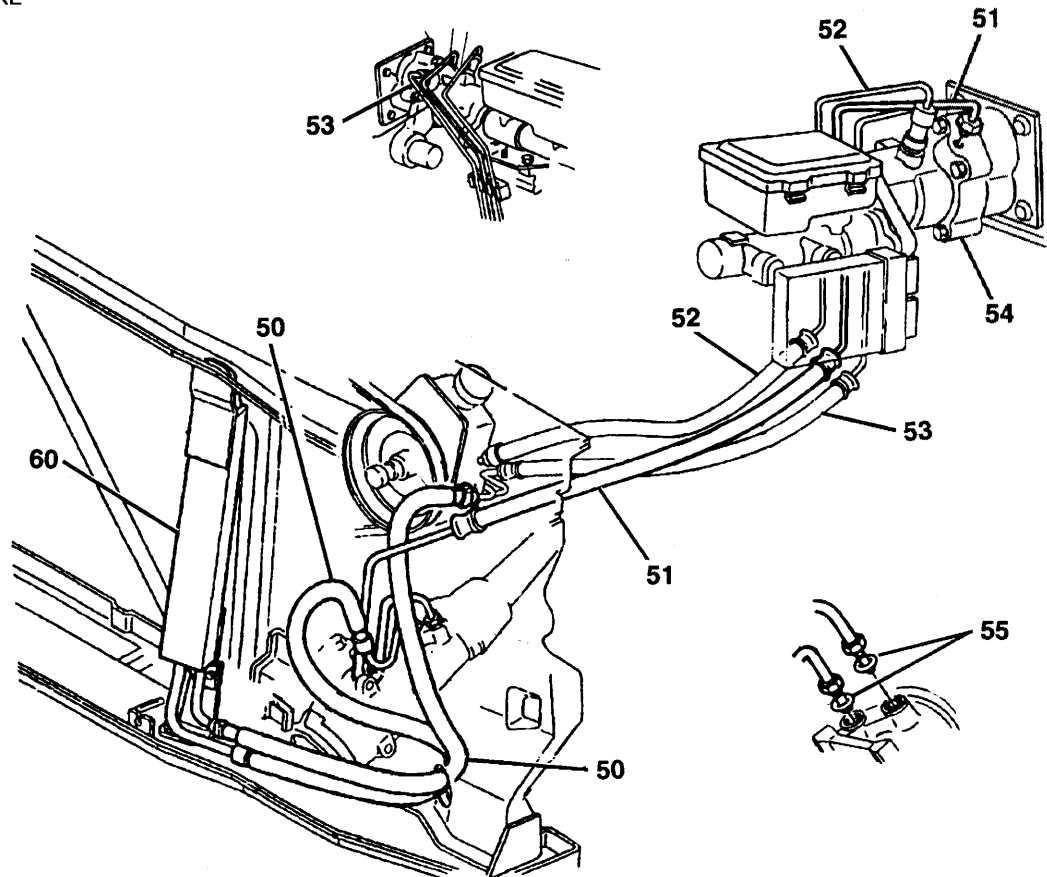


Figure 20—Hose Routing (CK2, 3 with 5.7L, 7.4L Engines)

V3403

- 50. HOSE, RETURN TO PUMP
- 51. HOSE, FEED TO STEERING GEAR FROM BRAKE BOOSTER
- 52. HOSE, RETURN TO PUMP FROM BRAKE BOOSTER
- 53. HOSE, FEED FROM PUMP TO BRAKE BOOSTER
- 54. BOOSTER, BRAKE
- 55. SEALS
- 60. COOLER



V3401

Figure 21—Hose Routing (CK1, 2, 3 with 6.5L Diesel Engines)

3B-20 POWER STEERING GEAR AND PUMP

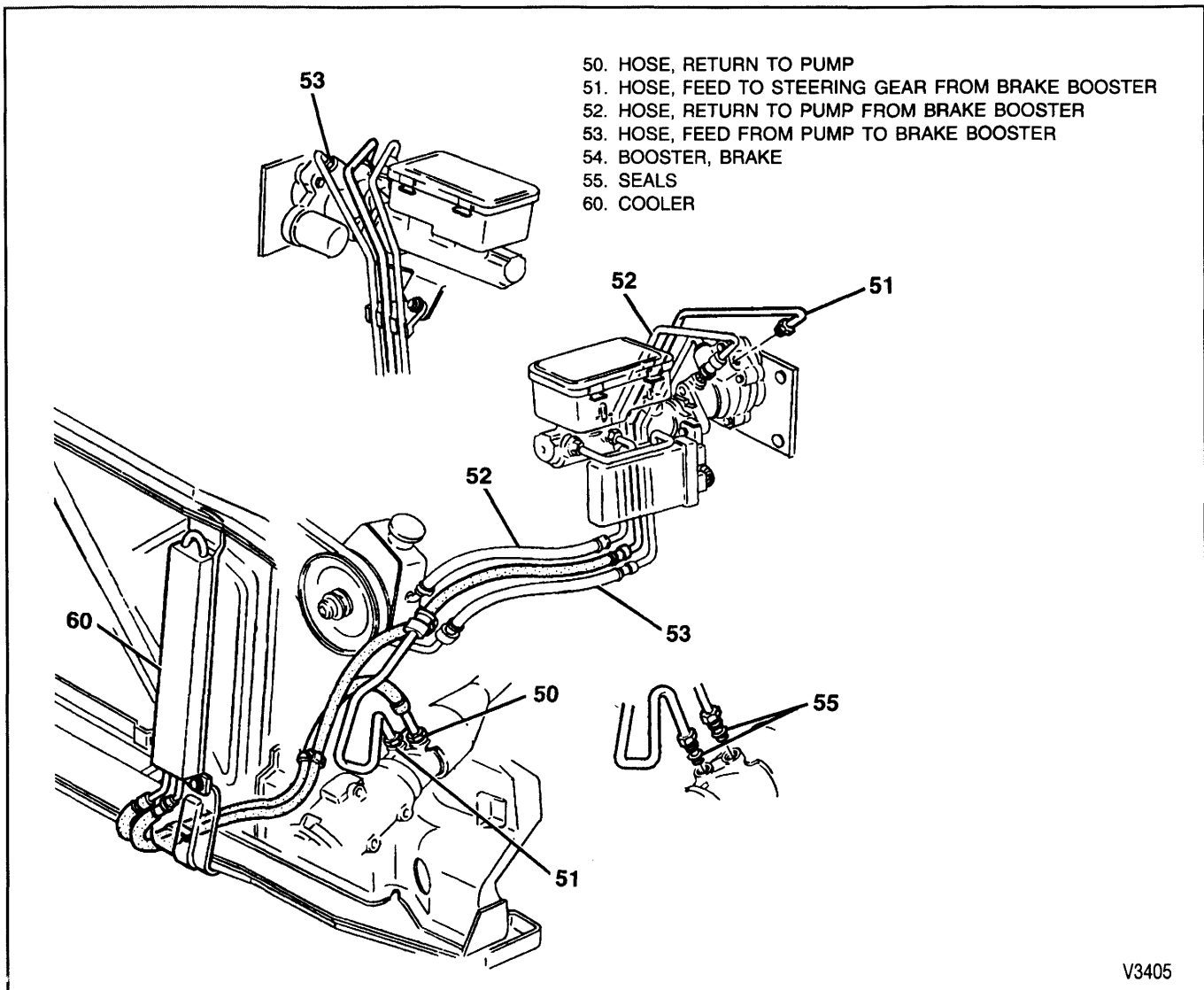


Figure 22—Hose Routing (C3HD I-Beam Front Axle)

V3405

SPECIFICATIONS

GENERAL SPECIFICATIONS

Power Steering Fluid

Fluid Power Steering Fluid No. 1050017 or equivalent

Adjustments

Over-Center Adjustment 0.6 to 1.2 N·m (6 to 10 lbs. in.)

FASTENER TIGHTENING SPECIFICATIONS

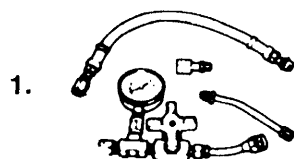
	N·m	Lbs. Ft.
Power Steering Gear		
Adjuster Jam Nuts—CK1, 2, 3	44	32
Coupling Clamp Bolt	30	22
Gear to Frame Bolts	135	100
Pressure Line Fitting	28	20
Side Cover Bolts—CK1, 2, 3	65	48
Power Steering Pump		
Front Brace Front Bolt (6.5L Engine)	40	30
Front Brace Nut (6.5L Engine)	40	30
Front Brace Rear Bolt (6.5L Engine)	40	30
Pressure Line Fitting	28	20
Pump Mounting Bolts	50	37
Rear Brace Bolt (7.4L Engine)	40	30
Rear Brace Nut	50	37
Rear Mounting Nut (6.5L Engine)	50	37

POWER STEERING SYSTEM PRESSURES

	kPa	PSI
C3HD	10101-10446	1465-1515
All Others	9308-9998	1350-1450

T2101

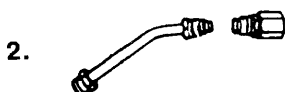
SPECIAL TOOLS



1. J 5176-20



6. J 6219



2. J 5176-20



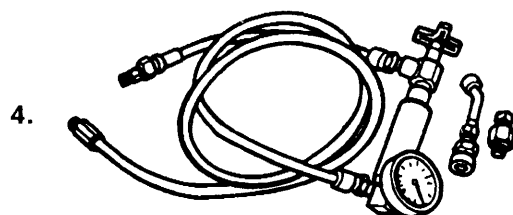
7. J 7624



3. J 5421-02



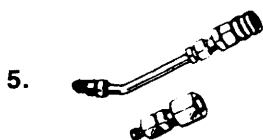
8. J 25034-B



4. J 25323-A



9. J 25033-B



5. J 29525

1. POWER STEERING PRESSURE TESTER
2. GAUGE ADAPTER 18MM POWER STEERING
3. THERMOMETER
4. POWER STEERING SYSTEM ANALYZER
5. POWER STEERING ANALYZER 18MM ADAPTER
6. PITMAN SHAFT SEAL INSTALLER
7. BEARING PRELOAD SPANNER WRENCH
8. POWER STEERING PUMP PULLEY REMOVER
9. POWER STEERING PUMP PULLEY INSTALLER

SECTION 3B3

STEERING LINKAGE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The steering linkage consists of a pitman arm, idler arm, relay rod, two adjustable tie rods, and a steering shock absorber (on some models).

When the steering wheel is turned, the gear rotates the pitman arm which forces the relay rod to one side. The tie rods, which are connected to the relay rod by ball studs, transfer the steering force to the wheels. The tie rods are adjustable and are used for toe-in adjustments. The relay rod is supported by the pitman arm and idler arm. The idler arm pivots on a support

attached to the frame rail. The steering shock absorber is attached to the frame and relay arm.

The 3500 heavy duty series steering linkage consists of a pitman arm, tie rod assembly, and adjustable drag link.

In the heavy duty series, when the wheel is turned, the gear rotates the pitman arm which forces the adjustable drag link to one side. The relay rod and tie rod then move sideways, actuating the steering knuckles

3B3-2 STEERING LINKAGE

and turning the wheels. A steering shock dampens the movement of the linkage and is attached from the tie rod assembly to the front axle assembly.

The overall condition of the steering linkage affects steering performance. If parts are bent, damaged, worn

or poorly lubricated, improper and possibly dangerous steering action will result.

Whenever any steering linkage components are repaired or replaced, check the steering geometry and front end alignment. Refer to SECTION 3A.

DIAGNOSIS OF STEERING LINKAGE

For diagnosis of steering linkage. Refer to SECTION 3B.

ON-VEHICLE SERVICE

STEERING LINKAGE INSPECTION

! Important

- Damaged or broken steering linkage components must be replaced. Never attempt to repair these parts by welding.

TIE RODS

There are two tie rod assemblies. Each assembly is made up of five pieces, consisting of a sleeve, two clamps, and two tie rod ends. The ends are threaded into the sleeve and secured with the clamps. Right and left hand threads are used for toe-in adjustments and steering gear centering.

The tie rod ends are self-adjusting for wear and require periodic lubrication. Refer to SECTION 0B. Tie rod ends should be replaced when excessive up-and-down motion is present, or when excessive end play or loss of motion at the ball stud exists.

Before any service is undertaken, note the position of the tie rod adjuster tube, and the direction from which the bolts are installed. The tie rod adjuster tube components may be rusted. If the torque required to remove the nut from the bolt exceeds 9 N.m (80 lbs. in.) discard the nuts and bolts. Apply penetrating oil between the clamp and tube and rotate the clamps until they move freely. Install all parts, with the correct part number, in the proper position.

IDLER ARM

L Inspect (Figure 1)

1. Raise the vehicle. Support the vehicle with jack stands. Allow the front wheels to rotate freely and the steering mechanism freedom to turn. Position the wheels in a straight ahead position.
 - On four wheel drive (K Models), the skid plate must be removed to access idler arm and steering linkage. Refer to SECTION 4C.
2. Place a spring scale near the relay rod end of the idler arm. Exert a 110 N (25 lb.) force upward and then downward (the force is forward and rearward) while measuring the total distance the arm moves. The total allowable deflection is 2 mm (0.080 inch). Replace the idler arm if it exceeds this test.

? Important

- Jerking the right wheel and tire assembly back and forth, causing an up and down movement of the idler arm, is NOT an acceptable testing procedure. There is no control on the amount of force being applied to the idler arm.
- Diagnose carefully whenever shimmy complaints are suspected of being caused by loose idler arms. Before inspecting suspension or steering components, technicians should consider areas such as dynamic imbalance, runout, or force variation of wheel and tire assemblies, and road surface irregularities. Refer to SECTION 3E.

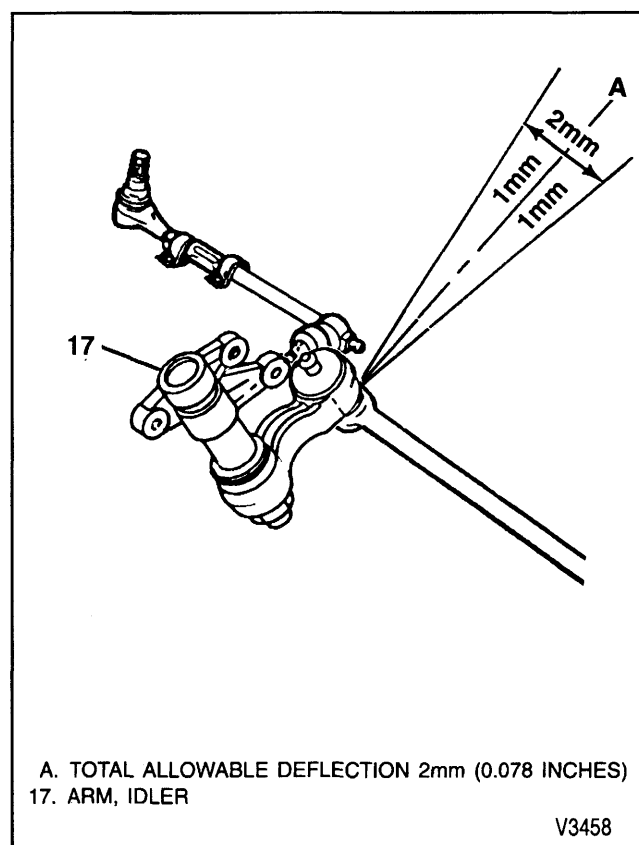


Figure 1—Idler Arm Movement Check

IDLER ARM REPLACEMENT

NOTICE: Do not attempt to free the ball stud by using a pickle fork or wedge type tool, because seal or bushing damage could result. Use the proper tool to separate all ball joints.

Remove or Disconnect (Figure 2 through 4)

Tool Required:

J 24319-01 Steering Linkage Puller.

- Raise the vehicle. Support the vehicle with jack stands.

NOTICE: For steps 2 and 4, refer to "Notice" on page 3B3-1.

1. Idler arm frame bolts (2) and nuts (13).
2. Idler arm ball stud nut (16). Do not reuse the nut.
3. Idler arm (15) from the relay rod (14). Use J 24319-01.

Inspect

- Ball stud threads for damage.
- Ball stud seal for cuts or other damage.

Clean

- Threads on the ball stud.

Install or Connect (Figures 2 through 4)

Tools Required:

J 29193 Steering Linkage Installer (12 mm).

J 29194 Steering Linkage Installer (14 mm).

NOTICE: For steps 1 and 3, refer to "Notice" on page 3B3-1.

- Position the idler arm mounting bracket (17) on the frame.
1. Frame bolts (2) and nuts (13) to the idler arm.

Tighten

- A. Bolt (2) to 80 N.m (59 lbs. ft.).
 - B. Bolt (2) to 80 N.m (59 lbs. ft.).
 - C. Bolt (2) to 80 N.m (59 lbs. ft.).
2. Relay rod (14) to the idler arm ball stud (15). Make sure the seal is on the stud. Tighten tool J 29193 or J 29194 to 54 N.m (40 lbs. ft.) to seat the tapers. Remove the tool.
 3. New prevailing torque nut (16) to the idler arm ball stud (15).

Tighten

- Nut to 54 N.m (40 lbs. ft.).
- Lower the vehicle.

Adjust

- Toe-in if necessary. Refer to SECTION 3A.

RELAY ROD REPLACEMENT

Important

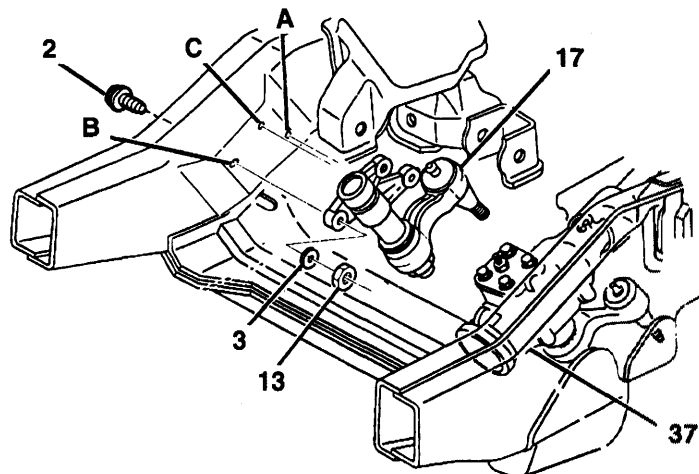
- Use the proper tool to separate all tie rod and ball joints.

Remove or Disconnect (Figures 2 through 6)

Tool Required:

J 24319-01 Steering Linkage Puller.

- Raise the vehicle. Support the vehicle with jack stands.
1. Steering shock absorber (29) from the relay rod (14).
 2. Inner tie rod ball joint (18) from the relay rod (14). Refer to "Tie Rod Replacement."
 3. Idler arm ball joint nut (16). Do not reuse.
 4. Pitman arm nut (11). Do not reuse.
 5. Relay rod (14) from the idler arm ball joint (15) using J 24319-01.
 6. Relay rod (14) from the pitman arm ball stud (5) using J 24319-01.



2. BOLT
3. WASHER
13. NUT, 80 N-m (59 FT. LBS.)
17. ARM, IDLER
37. GEAR, STEERING

V3470

Figure 2—Idler Arm Installation

3B3-4 STEERING LINKAGE

7. Drag link (31) from pitman shaft.



Inspect

- Threads on the tie rod for damage.
- Ball stud threads for damage.
- Ball stud seals for excessive wear.



Clean

- Threads on the ball stud.



Install or Connect (Figures 2 through 6)

Tools Required:

J 29193 Steering Linkage Installer (12 mm)

J 29194 Steering Linkage Installer (14 mm)

1. Relay rod (14) to the idler arm ball joint (15).
2. Relay rod (14) to the pitman arm ball stud (5).
 - A. Make sure the seal is on the stud.
 - B. Install J 29193 or J 29194 to ball stud.
 - C. Tighten to 62 N.m (48 lbs. ft.) to seat the tapers.
 - D. Remove the tool.

NOTICE: Refer to "Notice" on page 3B3-1.

3. New idler arm prevailing torque nut (16).
4. New pitman arm prevailing torque nut (11).



Tighten

- Nuts to 62 N.m (48 lbs. ft.).
5. Tie rod inner ball joints (18) to the relay rod (14). Refer to "Tie Rod Replacement."

DRAG LINK REPLACEMENT

I-Beam Front Axle (C3HD Models) Only



Important

- Use the proper tool to separate all ball joints.



Remove or Disconnect (Figure 5)

Tools Required:

J 24319-01 Steering Linkage Puller.

- Raise the vehicle. Support the vehicle with jack stands.
1. Nuts (38) from pitman arm ball stud and drag link ball stud.
 2. Drag link from pitman arm using J 2419-01.
 3. Drag link from tie rod assembly using J 2419-01.



Inspect

- Threads on the tie rod for damage.
- Ball stud threads for damage.
- Ball stud seals for excessive wear.



Clean

- Threads on the ball stud.



Install or Connect (Figure 5)

Tools Required:

J 29194 Steering Linkage Installer (14 mm)

1. Drag link ball stud to tie rod assembly.

2. Drag link to pitman arm ball stud.

A. Make sure the seal is on the studs.

B. Install J 29194.

C. Tighten to 62 N.m (48 lbs. ft.) to seat the tapers.

D. Remove the tool.

NOTICE: Refer to "Notice" on page 3B3-1.

3. Nuts (38) to pitman arm ball stud and drag link ball stud.



Tighten

- Nuts (38) to 54 N.m (40 lbs. ft.).
- Lower the vehicle.

PITMAN ARM REPLACEMENT

TWO WHEEL DRIVE (C-MODELS)



Important

- Use the proper tool to separate all ball joints.



Remove or Disconnect (Figure 3)

Tools Required:

J 24319-01 Steering Linkage Puller.

J 29107 Pitman Arm Puller.

J 6632-01 Pitman Arm Remover.

- Raise the vehicle. Support the vehicle with jack stands.
1. Relay rod nut (11) from the pitman arm ball stud (5). Do not reuse the nut.
 2. Relay rod (14) from the pitman arm ball stud (5) using J 24319-01.
 3. Pitman arm nut and washer.
 - Mark the pitman arm and the pitman shaft. This will permit proper alignment at assembly.

NOTICE: Do not hammer on pitman arm, pitman shaft, or puller. Damage to pitman arm or steering gear may result.

4. Pitman arm. Use J 6632-01 or J 29107.



Inspect

- Ball stud threads for damage.
- Ball stud seals for excessive wear.



Clean

- Threads on the ball stud.



Install or Connect (Figure 3)

Tools Required:

J 29193 Steering Linkage Installer (12 mm).

NOTICE: For steps 2 and 5, refer to "Notice" on page 3B3-1.

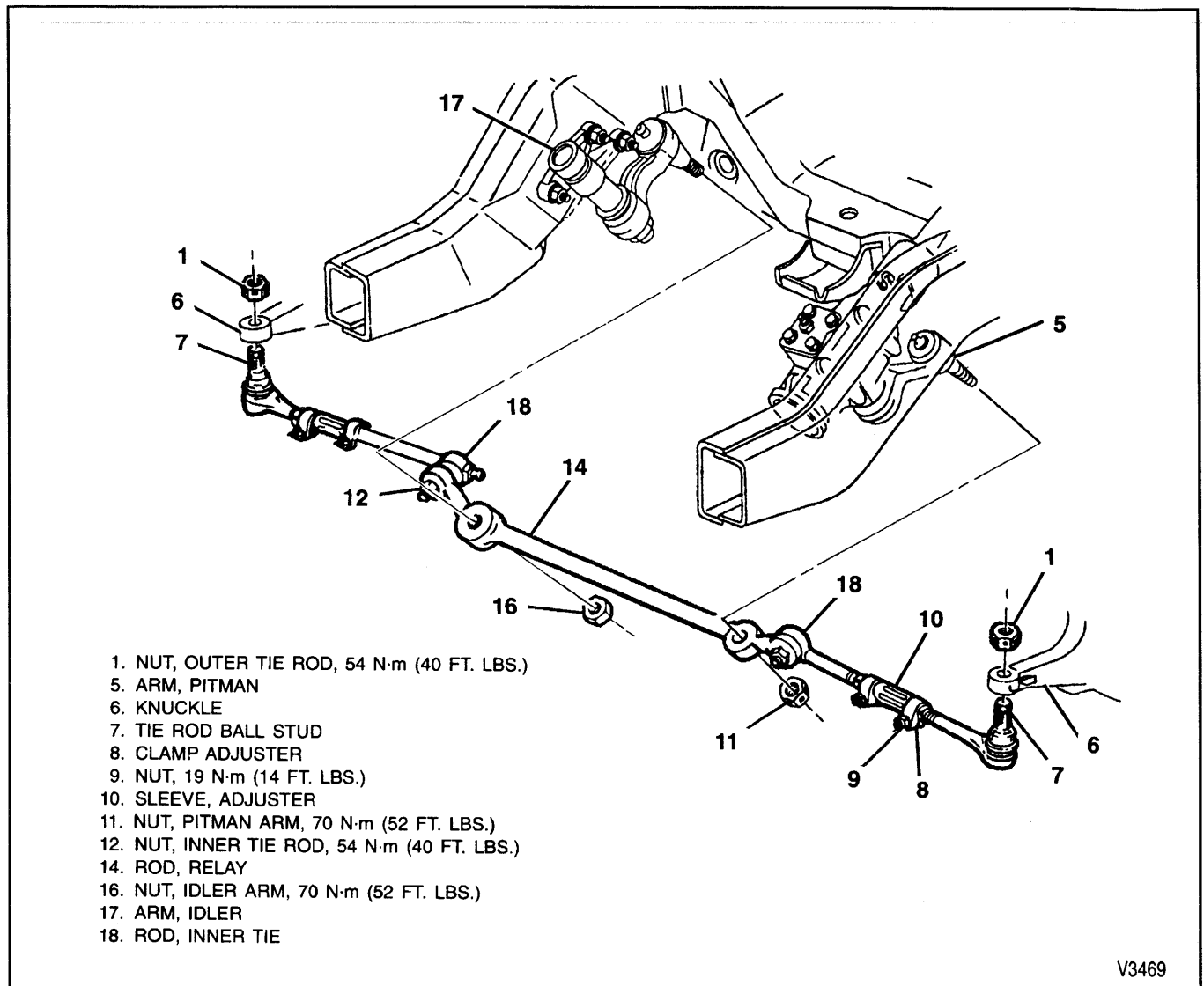


Figure 3—Steering Linkage—Two Wheel Drive (C-Models)

1. Pitman arm on the pitman shaft. Line up the marks made at removal.
2. Pitman arm washer and nut.



Tighten

- Pitman arm nut to 250 N·m (184 lbs. ft.).
3. Relay rod (14) to the pitman arm ball stud (5). Make sure the seal is on the stud.
 - Tighten J 29193 or J 29194 to 62 N·m (48 lbs. ft.) to seat the tapers. Remove the tool.
 4. New relay rod prevailing torque nut (11) to the pitman arm ball stud (5).



Tighten

- Nut (11) to 70 N·m (52 ft.lbs.).
- Lower the vehicle.

FOUR WHEEL DRIVE (K-MODELS)

Tools Required:

- J 24319-01 Steering Linkage Puller.
- J 29107 Pitman Arm Puller.
- J 6632-01 Pitman Arm Remover.



Remove or Disconnect (Figure 3)

- Raise the vehicle. Support the vehicle with jack stands.
1. Relay rod nut (11) from the pitman arm ball stud (5). Do not reuse the nut.
 2. Relay rod (14) from the pitman arm ball stud (5) using J 24319-01.
 3. Power steering gear. Refer to SECTION 3B.
 - Mark the pitman arm and the pitman shaft. This will permit proper alignment at assembly.

NOTICE: Do not hammer on pitman arm, pitman shaft, or puller. Damage to pitman arm or steering gear may result.

4. Pitman arm from pitman shaft of steering gear. Use J 6632-01 or J 29107.



Inspect

- Ball stud threads for damage.
- Ball stud seals for excessive wear.

3B3-6 STEERING LINKAGE



Clean

- Threads on the ball stud.



Install or Connect (Figure 3)

Tools Required:

J 29193 Steering Linkage Installer (12 mm).

NOTICE: For steps 2 and 4, refer to "Notice" on page 3B3-1.

1. Pitman arm on to pitman shaft of steering gear. Line up the marks made at removal.
2. Pitman arm washer and nut.



Tighten

- Pitman arm nut to 250 N.m (184 lbs. ft.).
3. Steering gear to frame of vehicle. Refer to SECTION 3B.
 4. Relay rod (14) to the pitman arm ball stud (5). Make sure the seal is on the stud.
 - Tighten J 29193 or J 29194 to 62 N.m (48 lbs. ft.) to seat the tapers. Remove the tool.
 5. New relay rod prevailing torque nut (11) to the pitman arm ball stud (5).



Tighten

- Nut (11) to 70 N.m (52 ft.lbs.).
- Lower the vehicle.

I-BEAM FRONT AXLE (C3HD MODELS)



Important

- Use the proper tool to separate all ball joints.



Remove or Disconnect (Figure 5)

Tools Required:

J 24319-01 Steering Linkage Puller.

J 29107 Pitman Arm Puller.

J 6632-01 Pitman Arm Remover.

- Raise the vehicle. Support the vehicle with jack stands.
1. Drag link (31) from pitman arm ball stud.
 2. Pitman arm nut (38) from steering gear shaft. (Do not reuse nut)
 - Mark the pitman arm and the pitman shaft. This will permit proper alignment at assembly.
 3. Pitman arm using J 6632-01 or J 29107.



Inspect

- Ball stud threads for damage.
- Ball stud seals for excessive wear.



Clean

- Threads on the ball stud.



Install or Connect (Figure 5)

Tools Required:

J 29194 Steering Linkage Installer (14 mm).

NOTICE: For steps 2 and 4, refer to "Notice" on page 3B3-1.

NOTICE: If a clamp type pitman arm is used, spread the pitman arm just enough, with a wedge, to slip the arm onto the pitman shaft. Do not spread the pitman arm more than required to slip over the pitman shaft with hand pressure. Do not hammer, or damage to the steering gear may result.

1. Pitman arm on the pitman shaft. Line up the marks made at removal.
2. Pitman arm washer and nut.



Tighten

- Pitman arm nut to 250 N.m (184 lbs. ft.).
3. Drag link (31) to the pitman arm ball stud. Make sure the seal is on the stud.
 - Tighten J 29194 to 62 N.m (48 lbs. ft.) to seat the tapers. Remove the tool.
 4. Pitman arm nut (38) to the pitman arm ball stud.



Tighten

- Nut (38) to 54 N.m (40 ft.lbs.).
- Lower the vehicle.

TIE ROD REPLACEMENT

There are two tie rod assemblies. Each assembly consists of five pieces, an adjuster tube, two clamps, and two tie rod ends. The ends are threaded into the sleeve and secured with the clamps. Right and left hand threads are used for toe-in adjustments. The tie rod ends should be replaced when excessive up and down motion is present, or when excessive end play or loss of motion at the ball stud exists.

Before servicing, note the position of the tie rod adjuster tube and the direction the clamp bolts are installed. The tie rod adjuster tube components may be rusted. If the torque required to remove the nut from bolt exceeds 9 N.m (80 lbs. in.) discard the nuts and bolts. Apply penetrating oil between the clamp and tube and rotate the clamps until they move freely. Install all parts (with the correct part number) in the proper position.



Important

- Use the proper tool J 6627-A to separate all tie rods and ball joints.

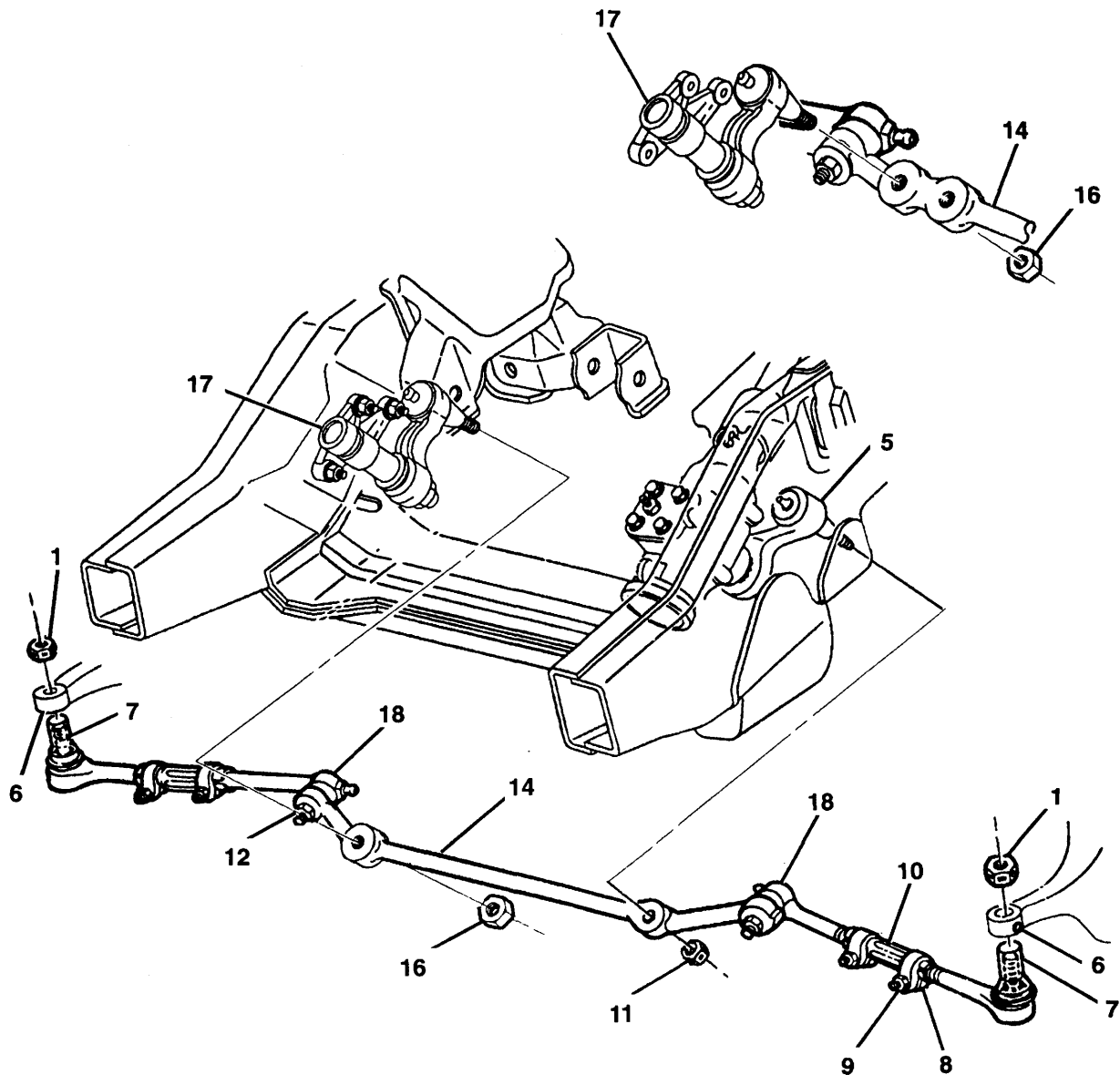


Remove or Disconnect (Figures 4 through 8)

Tool Required:

J 6627-A Wheel Stud Remover and Tie Rod Remover.

- Raise the vehicle. Support the vehicle with jack stands.
1. Nut (1) from the outer tie rod ball stud (7). Do not reuse the nut.
 2. Outer tie rod ball stud (7) from the steering knuckle (6) using J 6627-A.



1. NUT, OUTER TIE ROD, 54 N·m (40 FT. LBS.)
5. ARM, PITMAN
6. KNUCKLE
7. TIE ROD BALL STUD
8. CLAMP ADJUSTER
9. NUT, 19 N·m (14 FT. LBS.)
10. SLEEVE, ADJUSTER
11. NUT, PITMAN ARM, 70 N·m (52 FT. LBS.)
12. NUT, INNER TIE ROD, 54 N·m (40 FT. LBS.)
14. ROD, RELAY
16. NUT, IDLER ARM, 70 N·m (52 FT. LBS.)
17. ARM, IDLER
18. ROD, INNER TIE

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Figure 4—Steering Linkage—Four Wheel Drive (K-Models)

3B3-8 STEERING LINKAGE

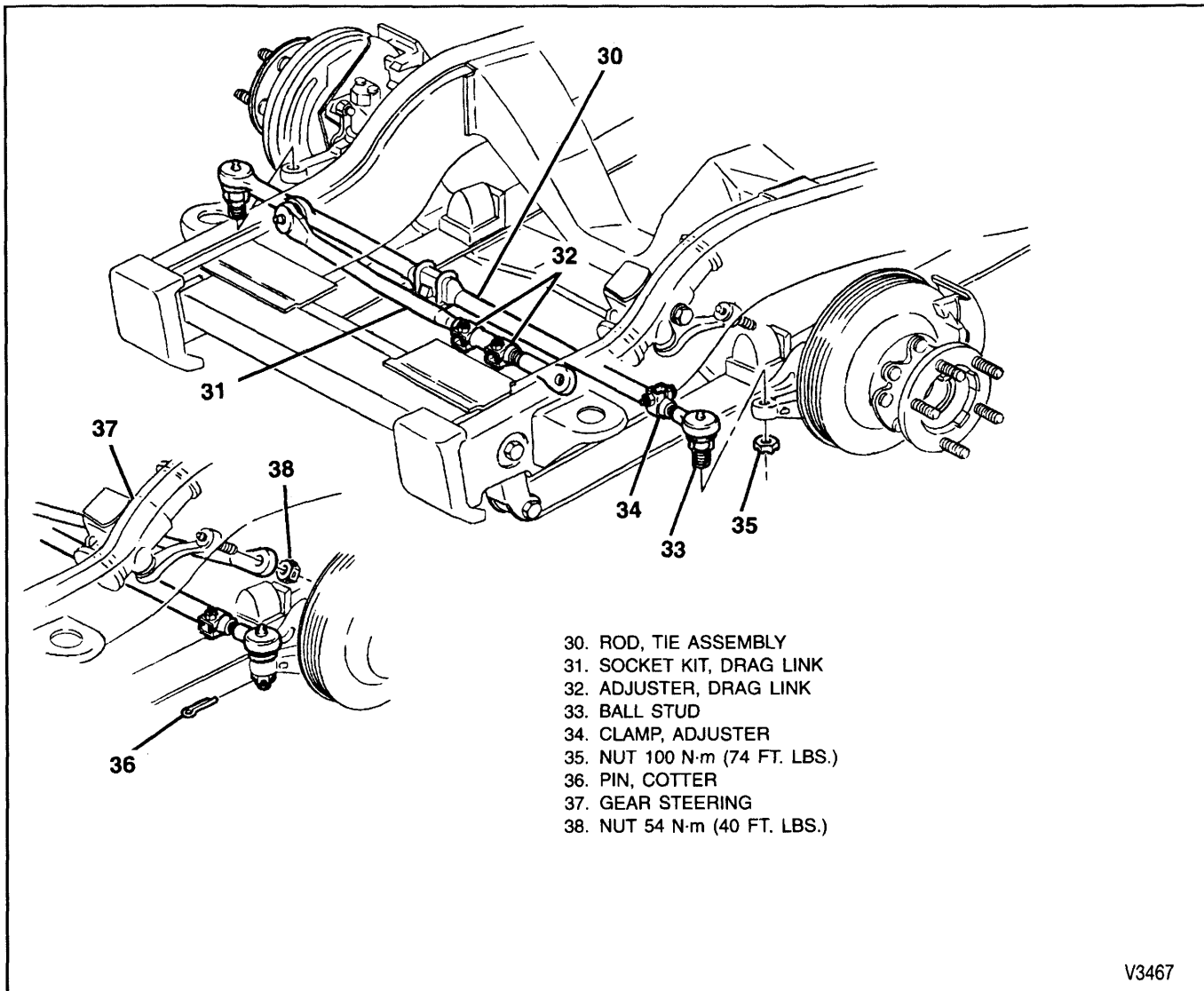


Figure 5—Steering Linkage—I-Beam Front Axle (C3HD models)

- Nut (1) from the inner tie rod ball stud (18). Do not reuse the nut.
- Inner tie rod ball stud (18) from the relay rod (14) using J 6627-A.
- Tie rod ends from the adjuster tube (10).
 - Loosen the clamp nuts (9).
 - Spread the clamps (8).
 - Unscrew the tie rods.



Inspect

- Tie rod ends for damage.
- Tie rod end seals for excessive wear.
- Ball stud threads for damage.
- Adjuster tubes for bending or damaged threads.



Clean

- The tapered surfaces.
- Threads on the ball stud and in the ball stud nut.



Install or Connect (Figures 3 and 4)

Tools Required:

J 29193 Steering Linkage Installer (12 mm).

NOTICE: For steps 2, 3, 4, and 5, refer to "Notice" on page 3B3-1.

- If the rod end was removed, lubricate the tie rod threads with chassis lubricant.

- Tie rod end to the adjuster tube (10). The number of threads on both the inner and outer rod ends must be equal within three threads.
- Inner tie rod ball studs (18) to the relay rod (14). The seal must be on the stud.



Tighten

- Stud (18) to 54 N·m (40 lbs. ft.) to seat the tapers, using J 29193.

- New prevailing torque nut (12) to the inner tie rod ball stud (18).



Tighten

- Nut to 54 N·m (40 lbs. ft.).

- Outer tie rod ball studs (7) to the steering knuckle (6).

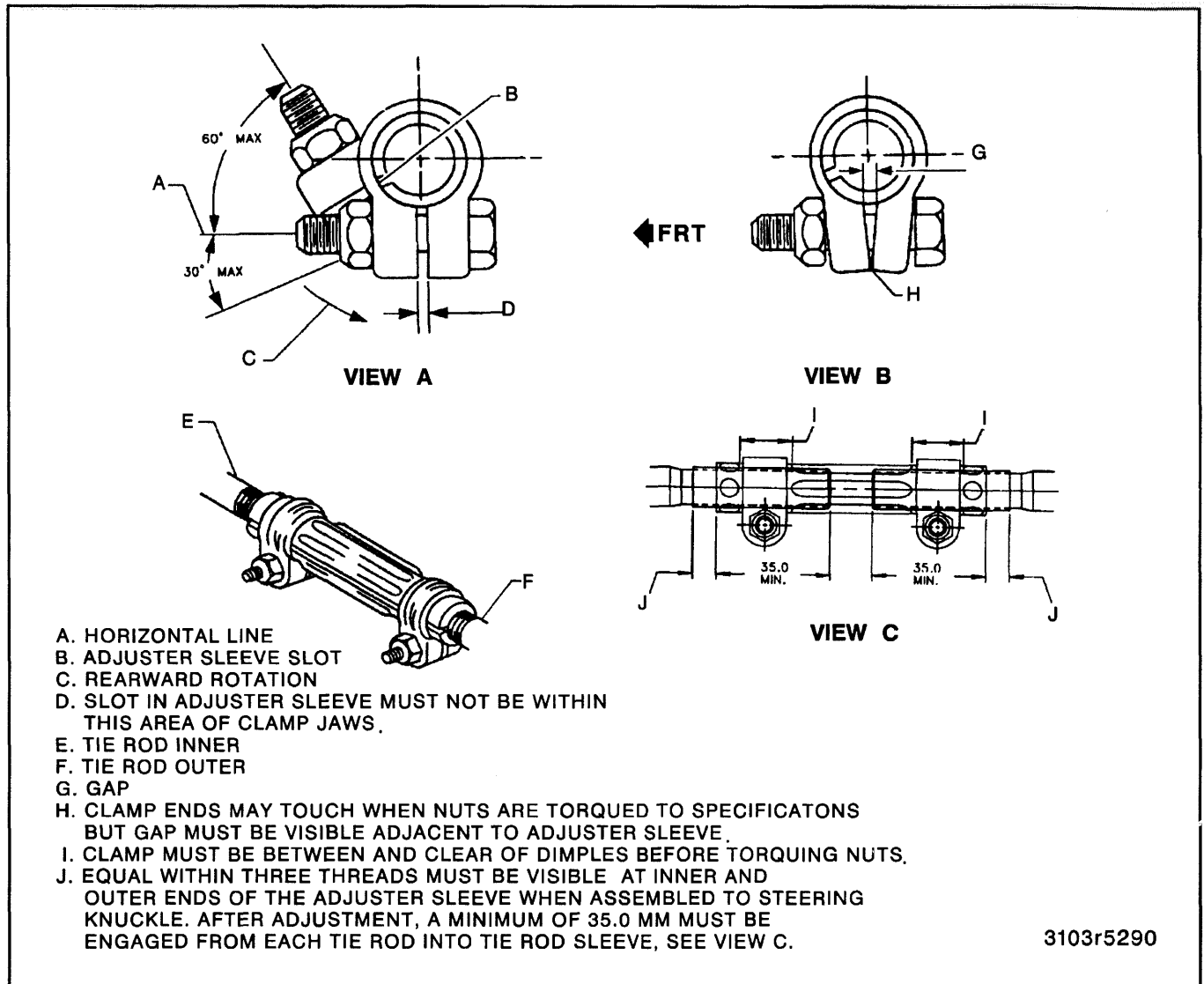


Figure 6—Tie Rod Clamp and Adjuster Tube Positioning



Tighten

- Stud (7) to 54 N.m (40 lbs. ft.) to seat the tapers, using J 29193.
5. New prevailing torque nut to the outer rod ball studs (7).



Tighten

- Nut to 54 N.m (40 lbs. ft.).



Adjust

- Toe-in. Refer to SECTION 3A.

I-BEAM FRONT AXLE (C3HD MODELS)

The heavy duty suspension uses only one adjustable tie rod end, connected to the left steering knuckle spindle. A ball socket is found at the end of the tie rod assembly that attaches to the right steering knuckle spindle. The tie rod assembly rod attaches to the steering gear by means of a drag link and ball socket with an adjuster sleeve near to the pitman arm stud hole.



Remove or Disconnect (Figure 5)

1. Cotter pin nut (35) at ball stud (33).
2. Nut (35) from ball stud (33).
3. Loosen nut and adjuster clamp (34).
4. Ball stud and tie rod end (33) from tie rod assembly (30).



Inspect

- Tie rod end for damage.
- Tie rod end seals for excessive wear.
- Threads on the relay rod and tie rod end for damage.
- Ball stud threads for damage.
- Adjuster tubes for bending or damaged threads.



Clean

- The tapered surfaces.
- Threads on the ball stud and in the ball stud nut.

3B3-10 STEERING LINKAGE

Install or Connect

NOTICE: For steps 3 and 5, refer to "Notice" on page 3B3-1.

1. Ball stud and tie rod end (33) to tie rod assembly.
2. Ball stud (33) into steering knuckle.
3. Nut (35) to ball stud and tie rod end.

Tighten

- Nut (35) to 88 N.m (65 lbs. ft.)
4. Cotter pin, align cotter pin slot in nut with hole through tie rod stud. (DO NOT back off nut to align slot).

Adjust

- Toe-in. Refer to SECTION 3A.
5. Adjuster clamp (34).

Tighten

- Adjuster clamp Nut 68 N.m (50 lbs. ft.).

TIE ROD CLAMP AND ADJUSTER TUBE POSITIONING

Adjust (Figure 6)

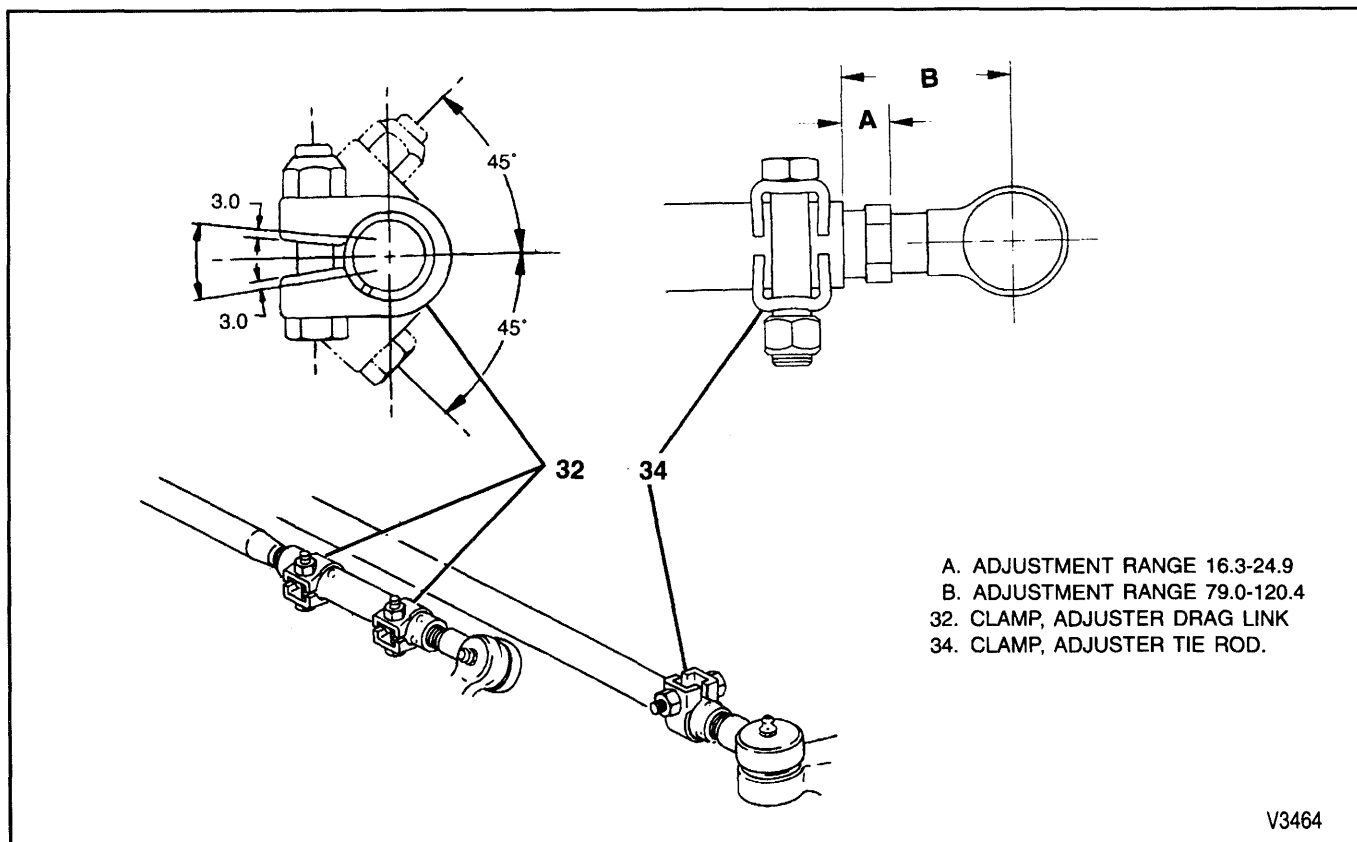
1. Position adjuster tube clamp bolts (figure 6). Before tightening the clamp bolts, be sure the following conditions have been met:

- A. The clamps must be positioned between the locating dimples at either end of the adjuster tube.
- B. The clamps must be positioned within the angular travel shown in figure 6.
- C. Both inner and outer tie rod ends must rotate for their full travel. The position of each tie rod end must be maintained as the clamps are tightened to ensure free movement of each joint.
- D. The clamp ends may touch when nuts are torqued to specification, but the gap next to the adjuster tube must not be less than the minimum dimension shown in figure 6.

I-BEAM FRONT AXLE (C3HD MODELS)

Adjust (Figure 7)

1. Align the front right wheel by using the drag link adjuster tube assembly.
 - A. Position the drag link adjuster clamps on the adjuster tube so the edge of the clamp ears do not fall in the adjuster tube slot.
 - B. Adjuster clamp must be located between (and not on) stamped adjuster tube dimples.
 - C. Ears of the drag link adjuster clamps must be rotationally positioned as in (figure 6).
 - D. Tighten the drag link to the recommended torque. Refer to "Specifications."
 - E. The drag link assembly must be capable of rocking on the socket pivots through a minimum of 8 degrees total after the clamp nuts are tightened.



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Figure 7—Tie Rod Clamp and Adjuster Tube Positioning—I-Beam Front Axle Models (C3HD Models)

- F. If tools are used to rotate the adjuster tube, special attention must be given to prevent damage to the corrosion protection coating.
2. Align the left front wheel by using the tie rod adjuster tube assembly.
- Position the tie rod adjuster clamps on the adjuster tube so the edge of the clamp jaws do not fall in the adjuster tube slot.
 - Adjuster clamps must be located between (and not on) the stamped adjuster tube dimples.
 - Tie rod adjuster tube clamps must be positioned as specified in figure 6.
 - Tighten the tie rod adjuster tube clamp nut to the recommended torque. Refer to "Specifications."
- If tools are used to rotate the adjuster tube, special attention must be given to prevent damage to the corrosion protection coating.

**Tighten**

- Adjuster tube clamp bolt nuts to "Specifications" at the end of this section.

STEERING SHOCK ABSORBER INSPECTION

Steering shock absorbers are a sealed assembly and are non-repairable. Replace the complete assembly if damaged.

**Inspect (Figures 8 and 9)**

- Shock absorber for fluid leakage. A slight film of fluid is allowable near the shaft seal. If there is excessive fluid leakage, be sure it's from the shock absorber and then replace the shock absorber.
- Shock absorber bushing for excessive wear. Replace the shock absorber if necessary.

3. Test the shock absorber.

- Disconnect the shock absorber from the frame or relay rod.
- Extend and compress the shock absorber using as much travel as possible. Resistance should be smooth and constant for each stroking rate. Replace the shock absorber if any binding or unusual noises are present.
- Install the end of the shock absorber and tighten to specifications.

STEERING SHOCK ABSORBER REPLACEMENT**FOUR WHEEL DRIVE (K MODELS)****Remove or Disconnect (Figure 8)**

- Relay rod cotter pin (27).
- Shock absorber lower ball stud nut (26).
- Shock absorber lower ball stud from the relay rod (14).
- Shock absorber mounting bolt nut (20).
- Mounting bolt (24).
- Shock absorber (29).

**Inspect**

- Shock absorber for leaks and damage.
- Shock absorber bushings for wear and damage.
- Mounting bolts and nuts for damage or corrosion.

**Install or Connect (Figure 8)**

- Shock absorber (29).
- Mounting bolt (24).
- Nut (20).
- Lower ball stud to the relay rod (14).

NOTICE: Refer to "Notice" on page 3B3-1.

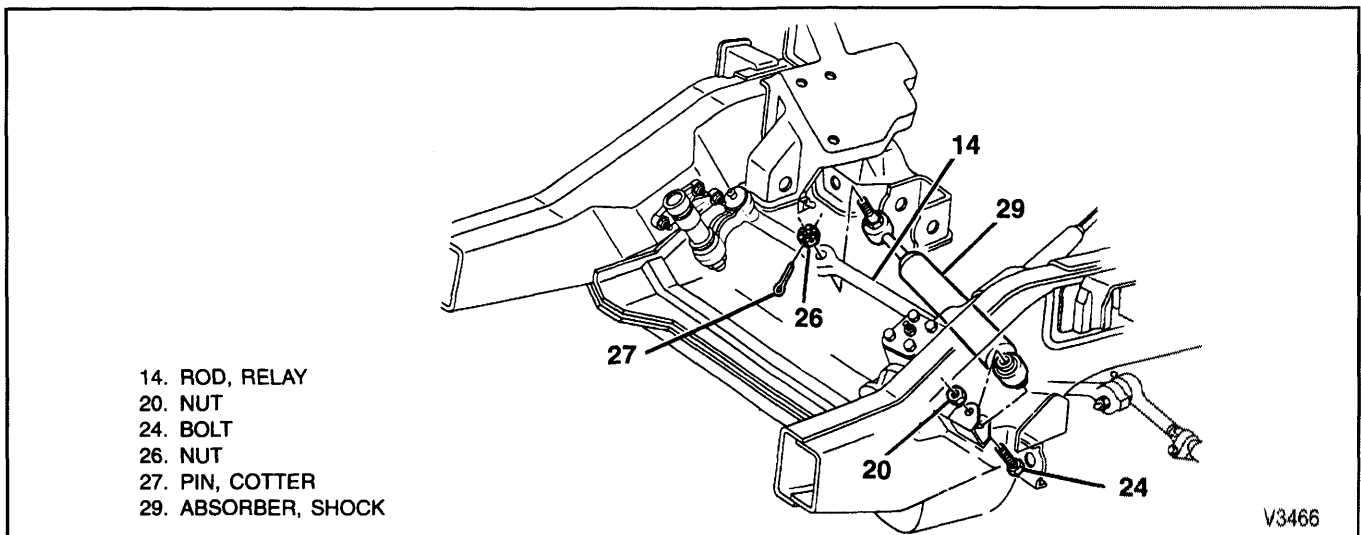


Figure 8—Steering Shock Absorber—K-Models

3B3-12 STEERING LINKAGE

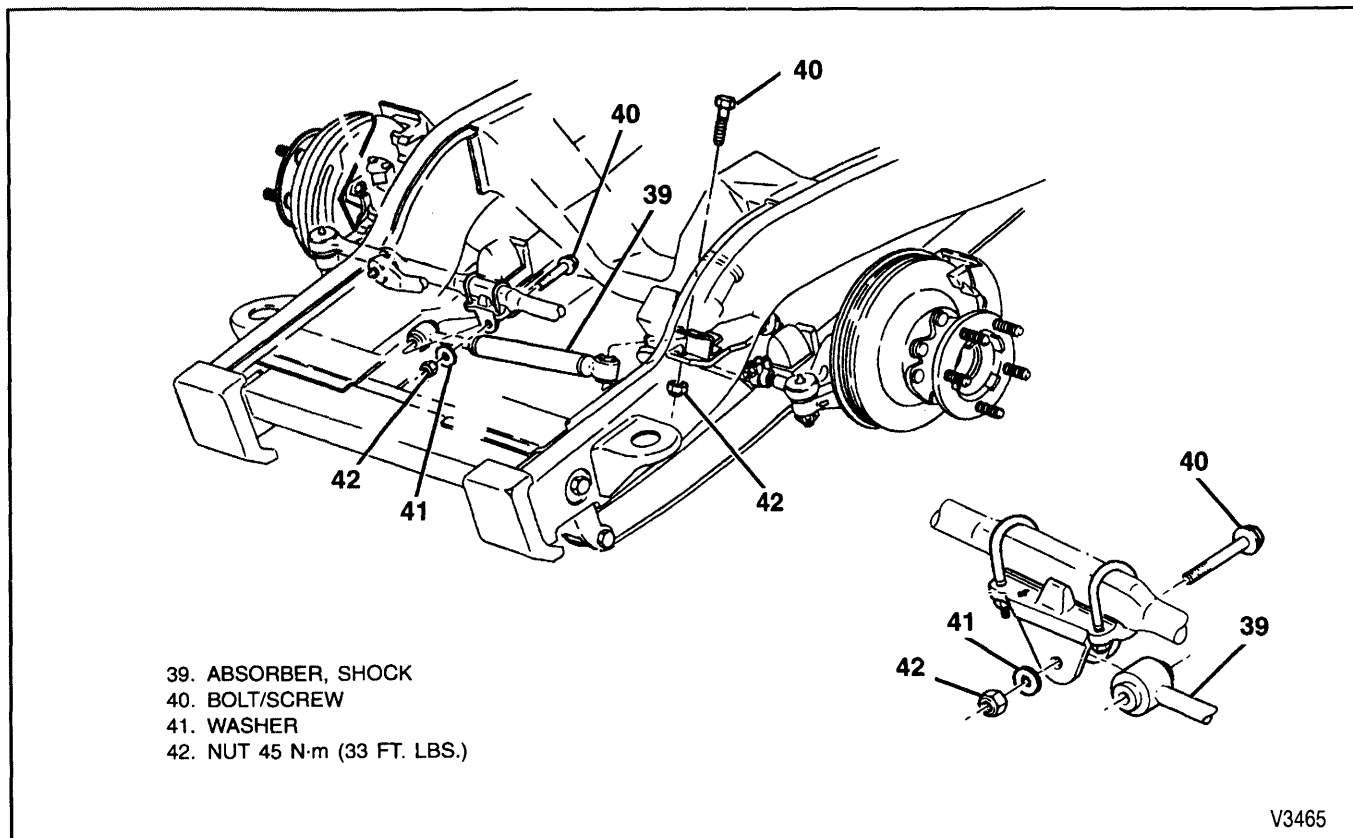


Figure 9—Steering Shock Absorber—C3HD I-Beam Front Axle Models

5. Nut (20).



Tighten

- Nut to 62 N·m (46 lbs. ft.). A maximum torque of 80 N·m (59 lbs. ft.) is allowed in order to align the cotter pin slot. Do not back off the nut to insert the cotter pin.

6. Cotter pin (27).

I-BEAM FRONT AXLE (C3HD MODELS)



Remove or Disconnect (Figure 9)

1. Nut (42) from bolt (40) at frame bracket.
2. Bolt/screw (40) from frame bracket.
3. Nut (42) from bolt (40) at tie rod assembly (30).
4. Bolt/screw (40) from tie rod assembly (30).

5. Shock absorber (39),



Install or Connect (Figure 14)

NOTICE: For steps 3 and 5, refer to "Notice" on page 3B3-1.

1. Shock absorber (39).
2. Bolt/screw (40) through bracket on tie rod assembly (30).
3. Nut (42) to bolt (41) at tie rod assembly (30).
4. Bolt/screw (40) through frame bracket.
5. Nut (42) to bolt (40) at frame bracket.



Tighten

- Nuts (42) to 45 N·m (33 lbs. ft.).

SPECIFICATIONS

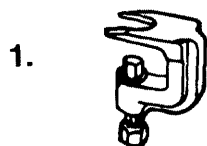
FASTENER TIGHTENING SPECIFICATIONS

C/K Models	N·m	Lbs. Ft.
Adjuster Tube Clamp Nut	19	14
Frame Bracket Nut.....	40	30
Idler Arm to Frame Nut.....	80	59
Idler Arm to Relay Rod Nut.....	70	52
Pitman Arm to Relay Rod Nut	70	52
Pitman Arm to Steering Gear Nut.....	250	184
Relay Rod to Tie Rod Nut.....	54	40
Steering Shock Absorber to Frame Bracket Nut.....	40	30
Steering Shock Absorber to Relay Rod Nut.....	63	46
Tie Rod to Steering Arm Nut.....	54	40

C3HD I-Beam Front Axle	N·m	Lbs. Ft.
Drag Link Adjuster Tube Nuts	68	50
Drag Link to Tie Rod	105	77
Pitman Arm to Drag Link.....	54	40
Pitman Arm to Steering Gear.....	250	184
Steering Shock Absorber to Tie Rod	45	33
Steering Shock to Axle Bracket	45	33
Tie Rod Adjuster Tube Nuts	68	50
Tie Rod to Steering Arm.....	88	65

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SPECIAL TOOLS



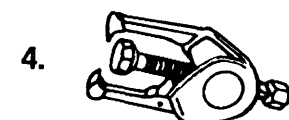
J-6627-A



J-6632-01



J-29107



J-24319-01



J-29193



J-29194

- 1. Tie Rod Puller
- 2. Pitman Arm Puller
- 3. Pitman Arm Puller
- 4. Universal Steering Linkage Puller
- 5. Steering Linkage Installer (12 mm) GM Torque Prevailing Nuts
- 6. Steering Linkage Installer (14 mm) GM Torque Prevailing Nuts

SECTION 3C

FRONT SUSPENSION AND AXLE

***NOTICE:** When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.*

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GENERAL DESCRIPTION

The front suspension (figure 1) is designed to allow each wheel to compensate for changes in the road surface level without appreciably affecting the opposite wheel. Each wheel is independently connected to the frame by a steering knuckle, ball joint assemblies, and upper and lower control arms. The front wheels are held in correct relationship to each other by two tie rods which are connected to steering arms on the knuckles and to an relay rod.

Two-wheel drive "C" Series models have a front suspension consisting of coil springs that are mounted between the spring housings on the frame and the lower control arms. Shock absorbers are mounted inside the coil springs and attached to the lower control arms by bolts and nuts. The upper portion of each shock absorber extends through a frame bracket and is secured with two grommets, two grommet retainers, and a nut.

Side roll of the front suspension on some models is controlled by a spring steel stabilizer shaft. It is mounted in rubber bushings which are held to the frame side rails by brackets. The ends of the stabilizer are connected to the lower control arms by link bolts isolated by rubber grommets.

A ball joint assembly is riveted to the outer end of the upper control arm and is attached to the steering knuckle by a castellated nut and cotter pin.

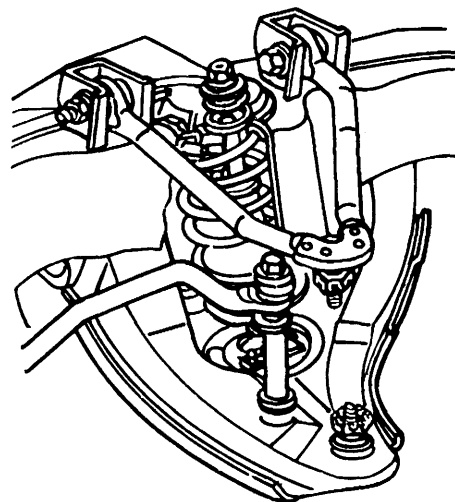
The inner ends of the lower control arm have pressed-in bushings. Bolts, passing through the bushings, attach the arm to the frame. The lower ball joint assembly is a press fit in the lower control arm and attaches to the steering knuckle with a nut and cotter pin.

Rubber grease seals are provided at ball socket assemblies to keep dirt and moisture from entering the joint and damaging bearing surfaces. Also, all ball joints have grease fittings for routine maintenance.

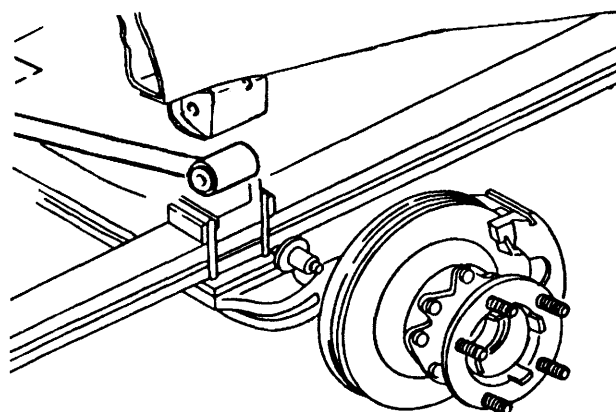
Four-wheel drive "K" Series models have a front suspension consisting of control arms, stabilizer shaft, shock absorber, and a right and left torsion bar. Torsion bars are used instead of conventional coil springs. The front end of the torsion bar is attached to the lower control arm. The rear of the torsion bar is mounted into an adjustable arm at the torsion bar crossmember. Vehicle trim height is controlled by this arm adjustment.

"K" Series models have sealed front wheel bearings that are pre-adjusted and require no lubrication maintenance. Darkened areas on the bearing assembly are caused by a heat treatment process and do not require bearing replacement.

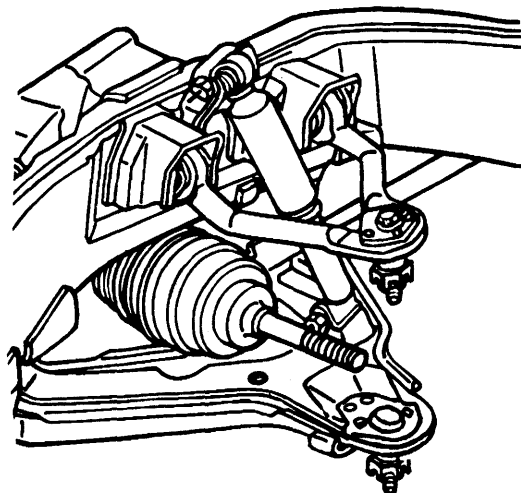
A heavy-duty front suspension is standard on the C3HD model. This suspension is centered around a solid I-beam axle and includes taper leaf springs, shock absorbers and a stabilizer shaft.



C SERIES



C3HD



K SERIES

F3620

Figure 1—Front Suspension

DIAGNOSIS OF FRONT SUSPENSION

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hard Steering	1. Steering linkage needs lubrication. 2. Low or uneven front tire pressure. 3. Incorrect front wheel alignment (manual steering). 4. Worn ball joints.	1. Lubricate the linkage. 2. Inflate tires to the recommended pressure. 3. Check and align the front suspension. 4. Check free play.
Poor Directional Stability	1. Steering linkage needs lubrication. 2. Low or uneven tire pressure. 3. Loose wheel bearings. 4. Incorrect front wheel alignment (caster). 5. Broken springs. 6. Malfunctioning shock absorber. 7. Broken stabilizer shaft or a missing link.	1. Lubricate the linkage. 2. Inflate tires to the recommended pressure. 3. Adjust or replace the wheel bearings. 4. Check and align the front suspension. 5. Replace the springs. 6. Check and replace the shock absorber. 7. Replace the stabilizer shaft or link.
Front Wheel Shimmy (Smooth Road Shake)	1. Tire and wheel are out of balance or out of round. 2. Worn or loose wheel bearings. 3. Worn ball joints. 4. Malfunctioning shock absorber.	1. Balance the tires, check runout. 2. Adjust the wheel bearings. 3. Replace the ball joints. 4. Check and replace the shock absorber.
Vehicle Pulls to One Side (No Braking Action)	1. Low or uneven tire pressure. 2. Front or rear brakes dragging. 3. Broken or sagging front spring. 4. Incorrect front wheel alignment (camber).	1. Inflate the tires to the recommended pressure. 2. Adjust the brakes. 3. Replace the spring. 4. Check and align the front suspension.
Noise in the Front End	1. Steering linkage needs lubrication. 2. Loose shock absorber or worn bushings. 3. Worn control arm bushings. 4. Worn or loose wheel bearings. 5. Loose stabilizer shaft. 6. Loose wheel nuts. 7. Spring is improperly positioned. 8. Loose suspension bolts. 9. Worn king pins and bushings.	1. Lubricate at the recommended intervals. 2. Tighten the bolts or replace the shock absorber. 3. Replace the bushings or control arm. 4. Adjust or replace the wheel bearings. 5. Tighten all the stabilizer shaft attachments. 6. Tighten the wheel nuts. 7. Reposition the spring. 8. Tighten to specifications or replace. 9. Replace bushings and king pins.
Wheel Tramp	1. Tire and the wheel are out of balance. 2. Tire and the wheel are out of round. 3. Blister or bump on the tire. 4. Improper shock absorber action.	1. Balance the wheels. 2. Replace the tire. 3. Replace the tire. 4. Replace the shock absorber.
Excessive or Uneven Tire Wear	1. Underinflated or overinflated tires. 2. Improper toe-in. 3. Wheels are out of balance. 4. Hard driving. 5. Overloading the vehicle.	1. Inflate the tire to the recommended pressure. 2. Adjust toe-in setting. 3. Balance the wheels. 4. Follow proper driving techniques. 5. Do not exceed the maximum recommended payload rating.
Scuffed Tires	1. Toe-in is incorrect. 2. Excessive speed on turns. 3. Tires are improperly inflated. 4. Suspension arm is bent or twisted.	1. Adjust toe-in setting. 2. Follow proper driving techniques. 3. Inflate the tires to the recommended pressure. 4. Replace the suspension arm.

3C-4 FRONT SUSPENSION AND AXLE

DIAGNOSIS OF FRONT SUSPENSION (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Cupped Tires	1. Front shock absorbers are defective. 2. Worn ball joints. 3. Wheel bearings are incorrectly adjusted or worn. 4. Wheel and tire is out of balance. 5. Excessive tire or wheel runout.	1. Replace the shock absorbers. 2. Replace the ball joints. 3. Adjust or replace the wheel bearings (also replace the races). 4. Balance the wheel and tire. 5. Check and compensate for runout.
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BALL JOINT WEAR CHECK

- Be sure the vehicle rests on a level surface.
- Raise the vehicle and support it with suitable safety stands. Support the lower control arm with a floor stand or jack as far outboard as possible under the stabilizer shaft bracket (figure 2).

! Important

- The vehicle must be stable and should not rock on the floor stands.
 - The upper control arm bumper must not contact the frame.
1. Wipe the ball joints clean and check the seals for cuts or tears.
 - If a seal is cut or torn, the ball joint MUST be replaced.
 2. Adjust the wheel bearings. Refer to "Wheel Bearing Adjustment."
 3. Check the ball joints for vertical looseness.
 - With the vehicle on the jack stands, place a dial indicator against the spindle to show vertical movement (figure 3).
 - Pry between the lower control arm and the outer race while reading the dial indicator. This will show vertical looseness in the ball joints (figure 4).

- If the dial indicator reading is more than 2 mm (0.08-inch), replace the ball joint.

NOTICE: Do not pry between the lower arm and the drive axle seal or in such a manner that the ball joint seal is contacted. Damage to the seal will result (4WD).

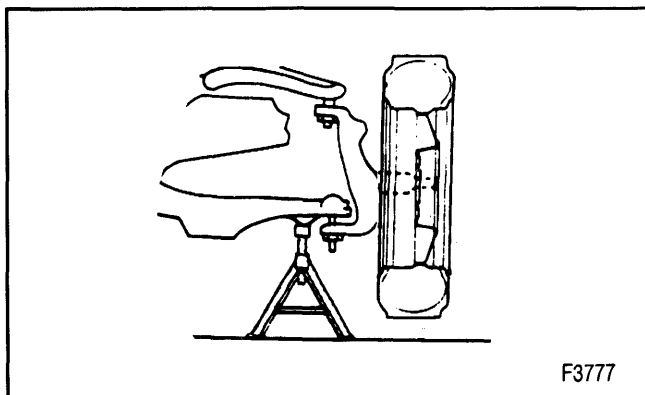


Figure 2—Supporting the Lower Control Arm

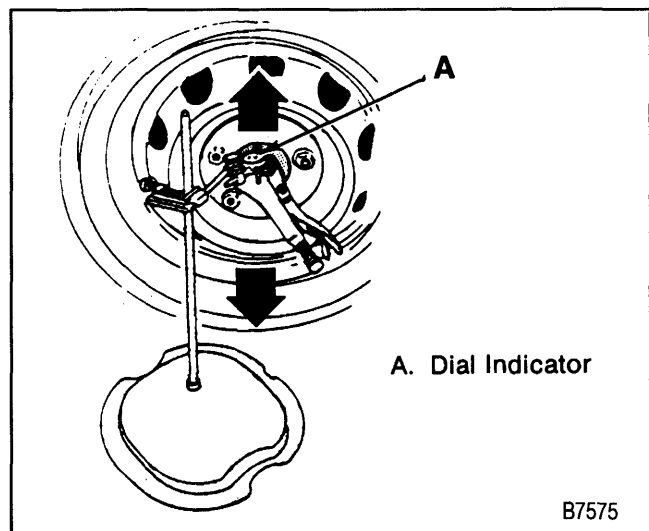


Figure 3—Dial Indicator Position

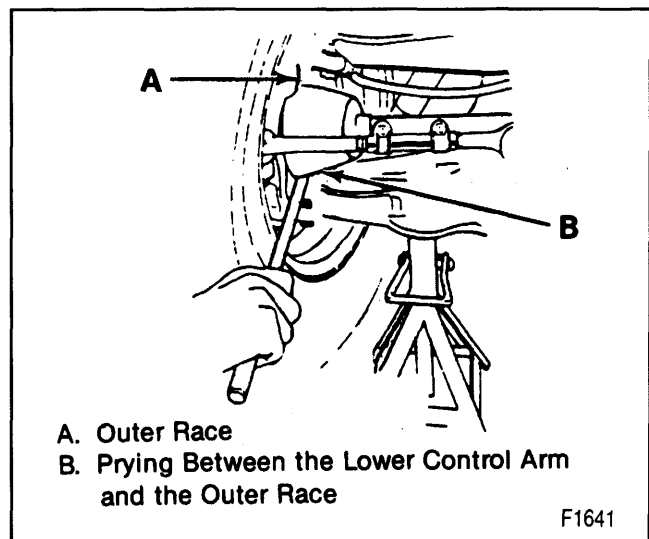


Figure 4—Checking Ball Joint Vertical Looseness

DIAGNOSIS OF SHOCK ABSORBERS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noisy Shocks	Loose mounting.	Check all mounting torques (bolt and/or nut).
Excessive Road Shock	1. Tire air pressure is too high. 2. Loose wheel bearings. 3. Camber adjustment is incorrect (negative camber contributes to road shock). 4. Weak or broken front spring. 5. Loose suspension components.	1. Deflate to correct pressure. 2. Adjust bearings. 3. Adjust camber. 4. Replace the spring. 5. Inspect, repair, and adjust as necessary.
Leaky Shocks	Seals are worn out.	Replace shocks.
Weak Shocks	1. Shocks are worn out. 2. Loss of shock fluid.	1. Replace shocks. 2. Replace shocks.
Vibration and Shimmy	1. Seal damage resulting in loss of lubricant, corrosion, excessive wear. 2. Tires and wheels, or brake drums, are out of balance. 3. Bent wheel or tire is out of round. 4. Wheel stud nuts torqued unevenly. 5. Loose steering linkage. 6. Wheel is loose on the hub. 7. Driveline universal joints are rough or defective (may be confused with steering vibration). 8. Malfunctioning shock absorbers.	1. Replace damaged parts as necessary. 2. Balance the tires and wheels, turn the brake drums. 3. Replace the wheel and remount, or replace the tire. 4. Retorque the wheel stud nuts. 5. Adjust, torque or repair as necessary. 6. Inspect the wheel bolt for damage. Replace the wheel if needed. Replace all wheel studs. 7. Repair driveline. 8. Replace the shock absorbers.
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SHOCK ABSORBER TEST

Bench Test—Non-Spiral Groove Pliacell Shock Absorbers

- Purging air from non-spiral groove shock absorbers is not necessary. These shock absorbers have a gas filled-cell in their reservoirs (as opposed to the air filled-cell in the spiral groove shock absorber reservoirs).
 - Remove the shock absorber from the vehicle. Refer to "Shock Absorber Removal."
1. Place the shock absorber in a vise with the jaws clamped on the shock absorber's top mounting stud.
 - The shock absorber should be held vertically in the vise—bottom end up.

- Do not clamp the vise jaws on the shock absorber's upper stem threads or reservoir.
2. Pump the shock absorber at various rates of speed and observe the rebound force.
 - Rebound force is normally stronger than compression force (approximately two to one).
 - Rebound force should be smooth and constant for each stroke rate.
 3. Compare with a good shock absorber.
 4. If one of the following is observed, replace the shock absorber.
 - A skip or lag at reversal near mid-stroke.
 - A seize (except at the extreme ends of travel).
 - A noise (grunt or squeal) after completing one full stroke in both directions.
 - A clicking noise at fast reversal.

TAPERED ROLLER BEARING DIAGNOSIS

Consider the following factors when diagnosing bearing condition:

1. General condition of all parts during disassembly and inspection.
2. Classify the failure with the aid of the illustrations.
3. Determine the cause.
4. Make all repairs following recommended procedures.



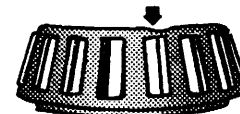
ABRASIVE ROLLER WEAR

Pattern on races and rollers caused by fine abrasives. Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



GALLING

Metal smears on roller ends due to overheat, lubricant failure or overload. Replace bearing, check seals and check for proper lubrication.



BENT CAGE

Cage damaged due to improper handling or tool usage. Replace bearing.



ABRASIVE STEP WEAR

Pattern on roller ends caused by fine abrasives. Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



ETCHING

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing. Replace bearings, check seals, and check for proper lubrication.



BENT CAGE

Cage damaged due to improper handling or tool usage. Replace bearing.



INDENTATIONS

Surface depressions on race and rollers caused by hard particles of foreign material. Clean all parts and housings. Check seals and replace bearings if rough or noisy.



MISALIGNMENT

Outer race misalignment due to foreign object. Clean related parts and replace bearing. Make sure races are properly sealed.

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Figure 5—Diagnosis of Wheel Bearings (Tapered Roller Bearings)

Diagnosis of Tapered Roller Bearings (con't)



FATIGUE SPALLING

Flaking of surface metal resulting from fatigue.
Replace bearing, clean all related parts.



STAIN DISCOLORATION

Discoloration can range from light brown to black caused by incorrect lubricant or moisture.
Re-use bearings if stains can be removed by light polishing or if no evidence of overheating is observed.
Check seals and related parts for damage.



FRETTAGE

Corrosion set up by small relative movement of parts with no lubrication.
Replace bearing. Clean related parts.
Check seals and check for proper lubrication.



CAGE WEAR

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.
Clean related parts and housings.
Check seals and replace bearings.



HEAT DISCOLORATION

Heat discoloration can range from faint yellow or dark blue resulting from overload or incorrect lubricant. Excessive heat can cause softening of races or rollers. To check for loss of temper on races or rollers a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas, a file drawn over a hard part will glide readily with no metal cutting.
Replace bearings if overheating damage is indicated.
Check seals and other parts.



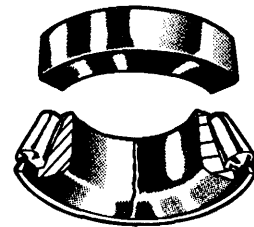
BRINELLING

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.
Replace bearing if rough or noisy.



SMEARS

Smearing of metal due to slippage. Slippage can be caused by poor fits, lubrication, overheating, overloads or handling damage.
Replace bearings, clean related parts and check for proper fit and lubrication.



CRACKED INNER RACE

Race cracked due to improper fit, cocking, or poor bearing seats.
Replace bearing and correct bearing seats.

Figure 6—Diagnosis of Wheel Bearings (Tapered Roller Bearings) (Cont.)

3C-8 FRONT SUSPENSION AND AXLE

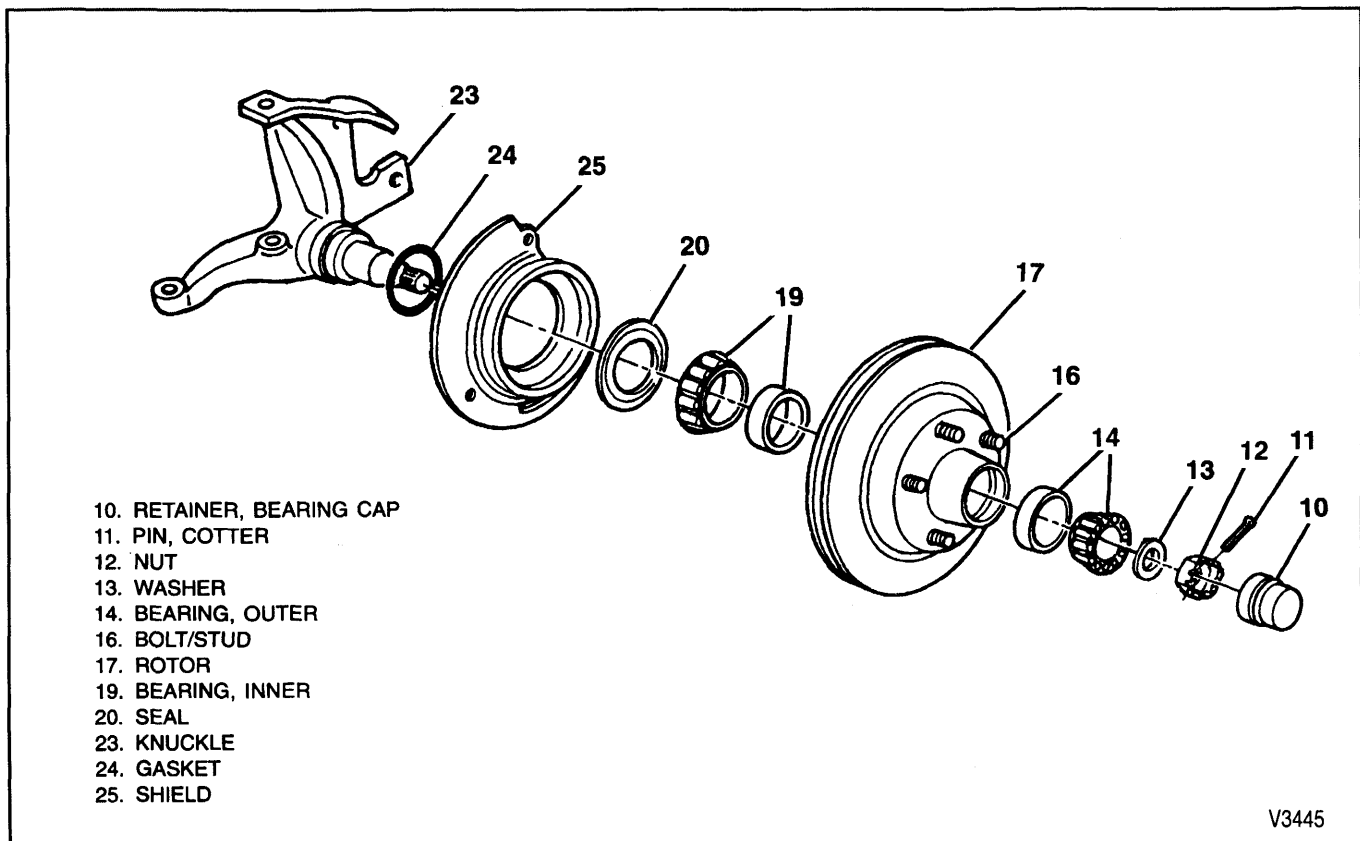


Figure 7—Hub, Knuckle and Bearing Components

DIAGNOSIS OF WHEEL BEARINGS

When diagnosing bearing condition, keep in mind the general condition of all parts during disassembly and inspection. Use figures 7 and 8 to classify the failure, and follow the recommended correction procedure.

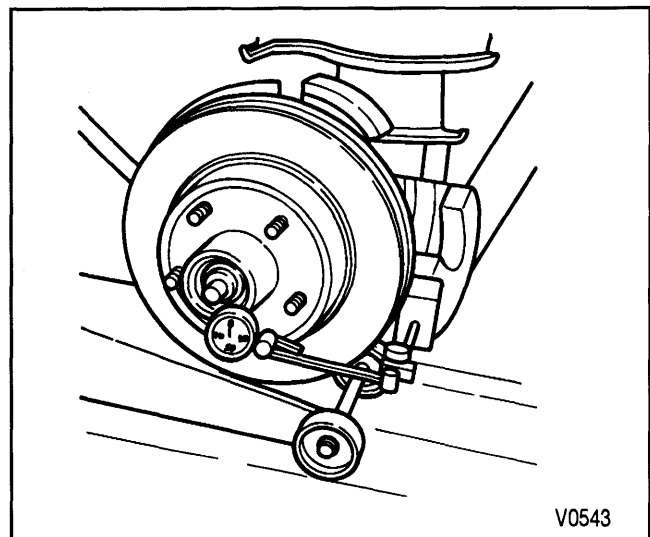


Figure 8—Checking Wheel Bearing Endplay

ON-VEHICLE SERVICE: TWO-WHEEL DRIVE FRONT SUSPENSION

WHEEL BEARING ADJUSTMENT

Important

- The continuous smooth functioning of the front suspension cannot be maintained unless the front wheel bearings are correctly adjusted.
- The bearings must be a slip fit on the spindle and the wheel bearing must be lubricated to ensure that the roller bearings will roll and not skid.
- The spindle nut must have a free-running fit on the spindle threads.

NOTICE: *Never preload the front wheel bearings. Damage can result by the steady pressure on the roller ends which comes from preloading.*

Remove or Disconnect (Figure 7)

- Raise the vehicle and support it with suitable safety stands.
1. Wheel cover, if used.
 2. Cap (10) from the hub.
 3. Cotter pin (11).

NOTICE: "Refer to 'Notice' on page 3C-1.

Tighten

- Nut (12) to 16 N·m (12 lbs. ft.) while turning the wheel forward by hand. This will seat the bearings.

Adjust

- Nut (12) to a "just loose" position by hand, then back the nut (12) off until the hole in the spindle aligns with a slot in the nut. **DO NOT BACK THE NUT (12) OFF MORE THAN 1/4 TURN.**

Install or Connect (Figure 7)

1. New cotter pin (11).
 - Be sure the cotter pin (11) ends do not interfere with the cap (10). Bend the ends of the cotter pin (11) against the nut (12) and cut off any extra pin length.

Measure

- The endplay in the hub/rotor assembly (17). Correct endplay should measure 0.03 to 0.20 mm (0.001 to 0.008 inch) (figure 8).
2. Cap (10) to the hub/rotor (17).
 3. Wheel cover, if used.
 - Lower the vehicle.

HUB, BEARING, AND SEAL REPLACEMENT

Remove or Disconnect (Figure 7)

1. Brake caliper. Refer to SECTION 5B1.

Important

- Support the caliper with a piece of wire to prevent damage to the brake line.
2. Cap (10) from the hub/rotor (17).
 3. Cotter pin (11), nut (12) and washer (13).
 4. Hub/rotor (17) from the spindle.
 - Be careful not to damage the outer bearing (14) and the spindle threads.
 5. Outer bearing (14).
 6. Seal (20).
 - Pry the seal (20) out and discard.
 7. Inner bearing (19).

Clean

- All parts in a solvent and air dry. Do not spin the bearings with compressed air.

Inspect

- Hub/rotor (17). Refer to SECTION 5B1.
- Bearings (14 and 19) and races for a cracked cage, worn or pitted rollers, cracks, scores, or a brinelled condition. Refer to "Diagnosis of Wheel Bearings" in this section. Replace parts as necessary.

Install or Connect (Figure 7)

- Be sure all parts are clean and free of grease.

Important

- Apply an approved high-temperature front wheel bearing grease to the spindle at the inner and outer bearing seat, shoulder and seal seat. Also finger apply a small amount of grease inboard of each bearing cup (15 and 18) in the hub/rotor (17). Pressure pack the bearings (14 and 19) with a greasing machine or hand pack them, making sure the grease is worked thoroughly into the rollers, cone and the cage.
1. Inner bearing (19) to the hub/rotor (17).
 - Apply an additional quantity of grease outboard of the inner bearing (19).
 2. Seal (20).
 - Lubricate the seal (20) lip.
 - Use a seal installation tool or flat block to press the seal (20) down flush with the hub.
 - Seat the outer bearing (14) and cup (15).

3C-10 FRONT SUSPENSION AND AXLE

3. Hub/rotor (17) to the spindle.
 - Be careful not to scuff the spindle threads.
4. Outer bearing (14) to the hub/rotor (17).
5. Washer (13).

NOTICE: Refer to "Notice" on page 3C-1.

6. Nut (12).



Tighten

- Nut (12) to 16 N.m (12 lbs. ft.) while turning the wheel assembly forward by hand. Apply grease to the outboard side of the outer bearing (14).



Important

- Adjust the wheel bearings. Refer to "Wheel Bearing Adjustment."
7. Brake caliper. Refer to SECTION 5B1.

WHEEL HUB BOLT REPLACEMENT



Remove or Disconnect (Figure 9)

Tools Required:

J 9746-02 Bearing Remover

- Raise the vehicle and support it with suitable safety stands.
1. Wheel assembly.
 2. Hub and rotor. Refer to "Hub, Bearing and Seal Replacement."

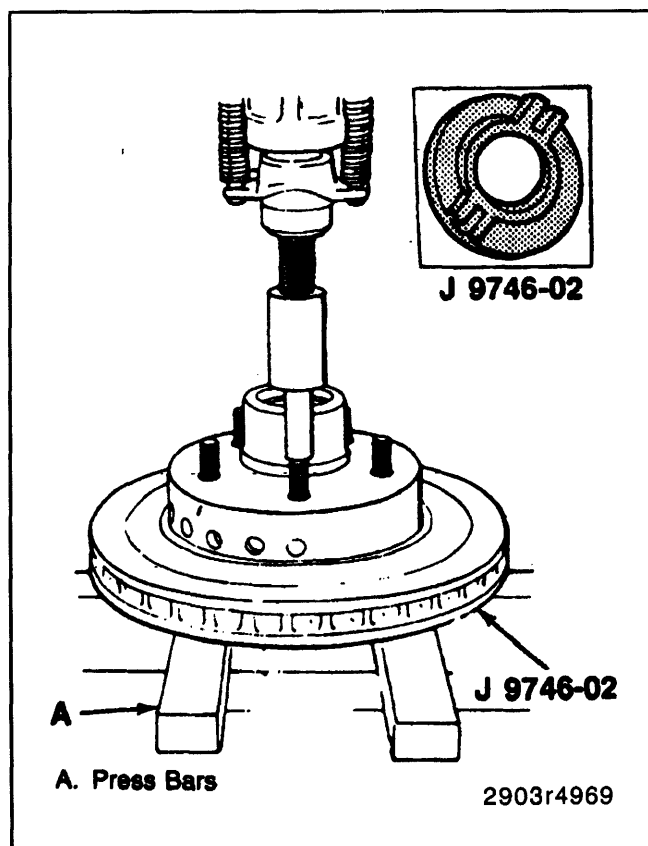


Figure 9—Removing the Wheel Hub Bolts

3. Bolt.

- Press the bolt out using an arbor press.
- Be careful not to damage the wheel mounting surface on the hub flange.



Install or Connect (Figure 9)

1. Bolt into the hole in the hub.
 - Start the serrated bolt into the hole in the hub by tapping lightly with a hammer.
 - Make sure the bolt is square with the hub before pressing on the arbor.
2. Hub and rotor. Refer to "Hub, Bearing, and Seal Replacement."
3. Wheel assembly.
 - Lower the vehicle.

SHOCK ABSORBER REPLACEMENT



Remove or Disconnect (Figure 10)

NOTICE: The front shock absorbers of the C/K truck are multifunctional. In addition to contributing to a smooth ride they also provide the only stop to the front suspension when fully extended. Therefore, when servicing the shock absorber, service replacement shock absorbers must be equivalent to original shock absorbers in both extended length and strength. Use of shocks not complying to original equipment length or strength could result in suspension over-travel or shock breakage. Suspension over-travel may result in suspension component breakage.

- Raise the vehicle and support it with suitable safety stands.
1. Nut (30).
 - Hold the shock absorber stem (33) with a wrench while backing the nut (30) off.
 2. Retainer (31).
 3. Grommet (32).
 4. Bolts (38).
 - Pull the shock absorber (36) out from below.
 - Lower grommet (34) and retainer (35) are on the stem (33).



Install or Connect (Figure 10)

NOTICE: For steps 5 and 6 refer to "Notice" on page 3C-1.

1. Retainer (35) and grommet (34) on the stem (33).
 - Fully extend the stem (33).
2. Shock absorber (36) up through the lower control arm (40) and spring (37).
 - Insert the stem (33) end through the hole in the upper control arm frame bracket (42).
3. Grommet (32) to the stem (33).
4. Retainer (31) to the stem (33).

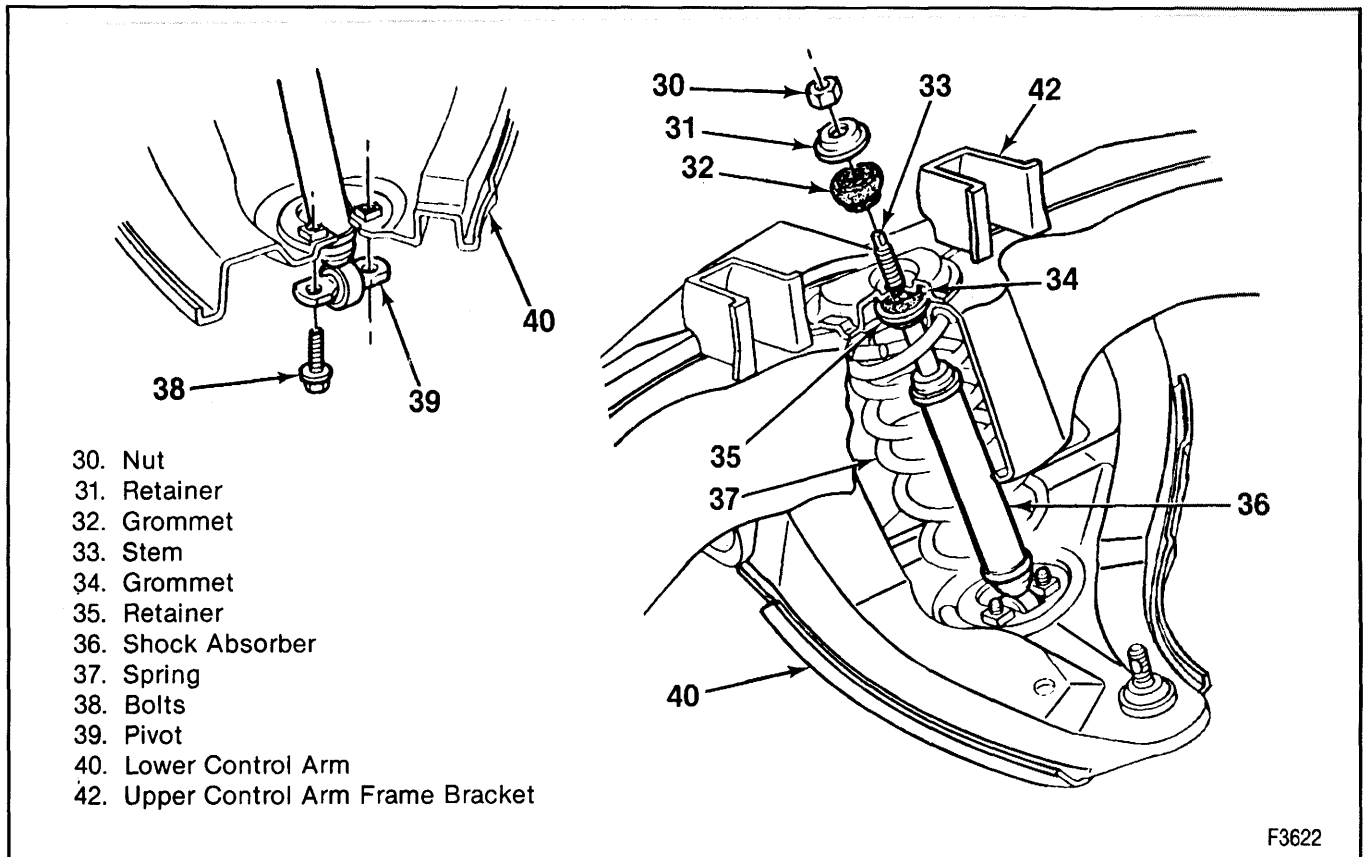


Figure 10—Attaching the Shock Absorber

5. Nut (30).



Tighten

- Nut (30) to 11 N.m (100 lbs. in.) while holding the stem (33) with a wrench.

6. Bolts (38) through pivot (39) holes to the lower control arm holes.



Tighten

- Bolts (38) to 27 N.m (20 lbs. ft.).
- Lower the vehicle.

STABILIZER SHAFT REPLACEMENT



Remove or Disconnect (Figure 11)

- Raise the vehicle and support it with suitable safety stands.

1. Nut (50) from the link bolt (62).



Important

- Be sure to remove parts from both the right and left side of the vehicle and keep them separated.

2. Link bolt (62).
3. Spacer (56).
4. Bolts (63).
5. Bracket (64).
6. Stabilizer shaft (53).

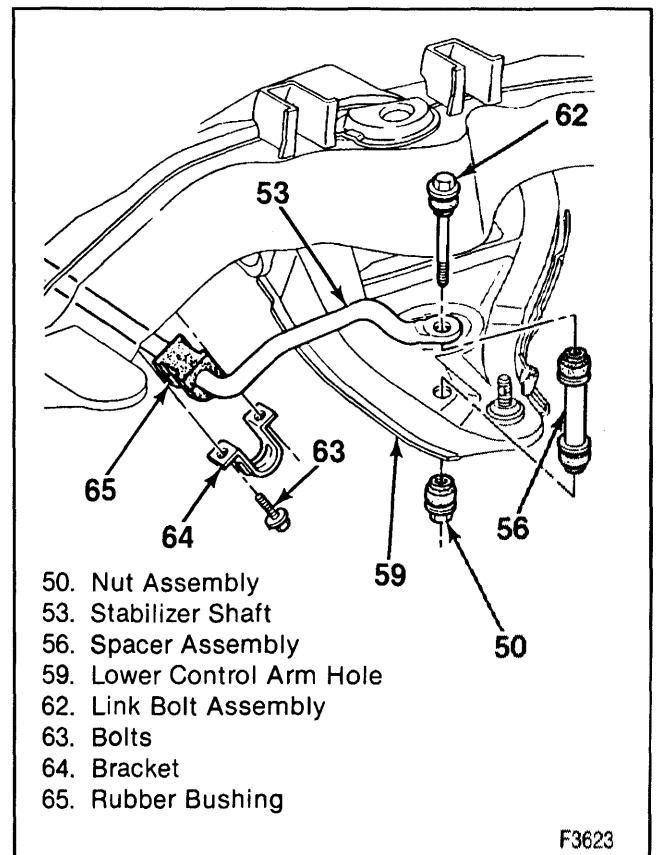


Figure 11—Stabilizer Shaft Components

3C-12 FRONT SUSPENSION AND AXLE

7. Rubber bushing (65).



Inspect

- All parts for wear and damage.



Install or Connect (Figure 11)

NOTICE: For steps 4 and 7, refer to "Notice" on page 3C-1.

1. Rubber bushings (65) to the stabilizer shaft (53).
 - Be sure the bushings (65) are placed on the stabilizer shaft (53) with slits facing toward the front of the vehicle.
2. Stabilizer shaft (53).
3. Brackets (64) over the bushings (65) and the stabilizer shaft (53).
4. Bolts (63) to the brackets (64) and the frame.



Tighten

- Bolts (63) to 33 N.m (24 lbs. ft.).
5. Spacer (56).
 6. Link bolt (62).
 7. Nuts (50).



Tighten

- Until the nut meets the end of the bolt threads for torque value.
- Nut (50) to 18 N.m (13 lbs. ft.).
- Lower the vehicle.

LOWER BALL JOINT REPLACEMENT



Remove or Disconnect (Figure 12)

Tools Required:

- J 9519-D Ball Joint Remover and Installer Set
- J 23742 Ball Joint Separator

- Raise the vehicle and support the frame with suitable safety stands.

1. Tire and wheel assembly.

- Place a floor jack under the control arm spring seat and raise it until it supports the control arm.

CAUTION: Floor jack must remain under the control arm spring seat during removal and installation to retain the spring and control arm in position or personal injury may result.

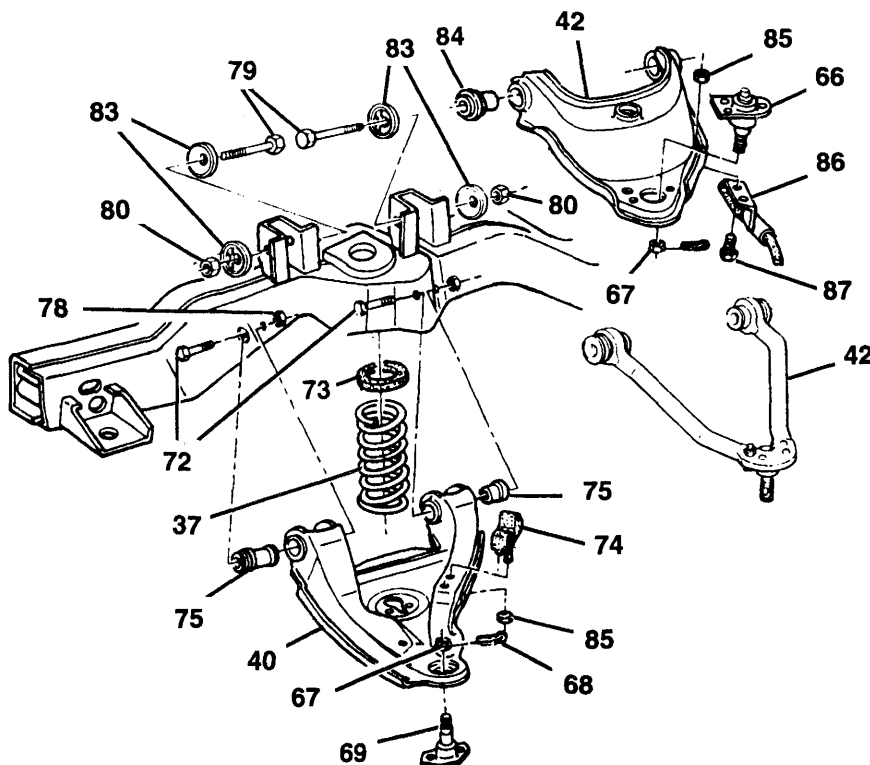
2. Brake caliper. Refer to SECTION 5B1.



Important

- Support the caliper with a piece of wire to prevent damage to the brake line.

37. SPRING, COIL
40. ARM, LOWER CONTROL
42. ARM, UPPER CONTROL
66. BALL JOINT, UPPER
67. NUT
68. PIN, COTTER
69. BALL JOINT, LOWER
72. BOLT
73. INSULATOR
74. BUMPER
75. BUSHING
78. NUT
79. BOLT
80. NUT
83. CAM
84. BUSHING
85. NUT
86. BRACKET
87. SCREW



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Figure 12—Control Arms and Components

3. Cotter pin and the nut (67).

- Use J 23742 to break the ball joint loose from the knuckle (figure 13).

4. Lower control arm (40) from the knuckle.

- Guide the control arm out of the splash shield with a screwdriver while lifting the upper control arm with a pry bar.



Important

- Block the knuckle assembly out of the way by placing a wooden block between the frame and upper control arm.
5. Lower ball joint (69) from the lower control arm.
- Use tools as shown in (figure 14).



Inspect

- The tapered hole in the steering knuckle and remove any dirt. If the hole is out of round, deformed or damaged, the knuckle must be replaced.

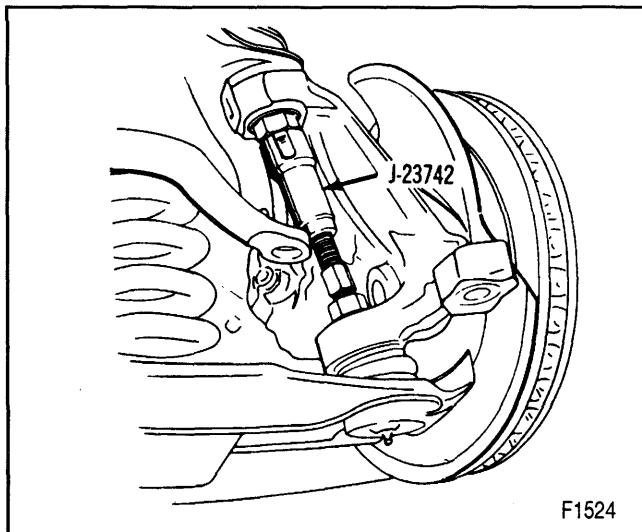


Figure 13—Disconnecting the Lower Ball Joint

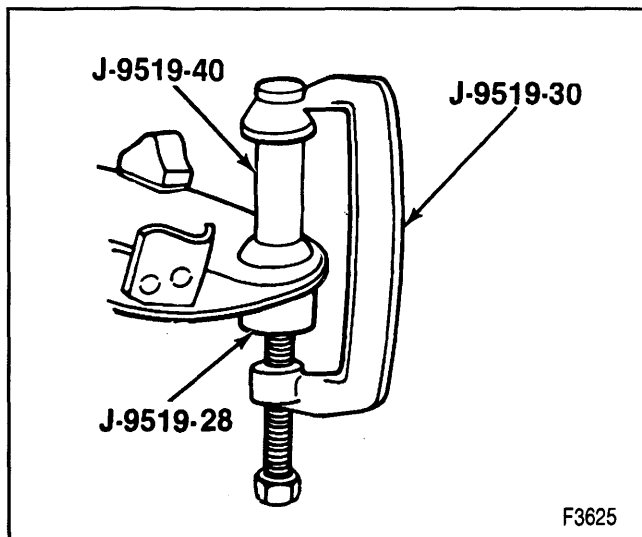


Figure 14—Removing the Lower Ball Joint



Install or Connect (Figure 12)

Tool Required:

J 9519-D Ball Joint Remover and Installer Set

1. New ball joint (69) into the lower control arm (40).

- Press in the ball joint using tools in (figure 15). The ball joint will bottom on the control arm.

2. Ball joint stud into the steering knuckle.

NOTICE: Refer to "Notice" on page 3C-1.

3. Stud nut (67) onto the stud.



Tighten

- Nut (67) to 115 N.m (84 lbs. ft.) and align the slot in the stud nut with the hole in the stud by tightening.

4. New cotter pin (68) to the stud.

5. Brake caliper. Refer to SECTION 5B1.

6. Tire and wheel assembly.

- Lower the vehicle.



Important

- Check the front end alignment. Refer to SECTION 3A.

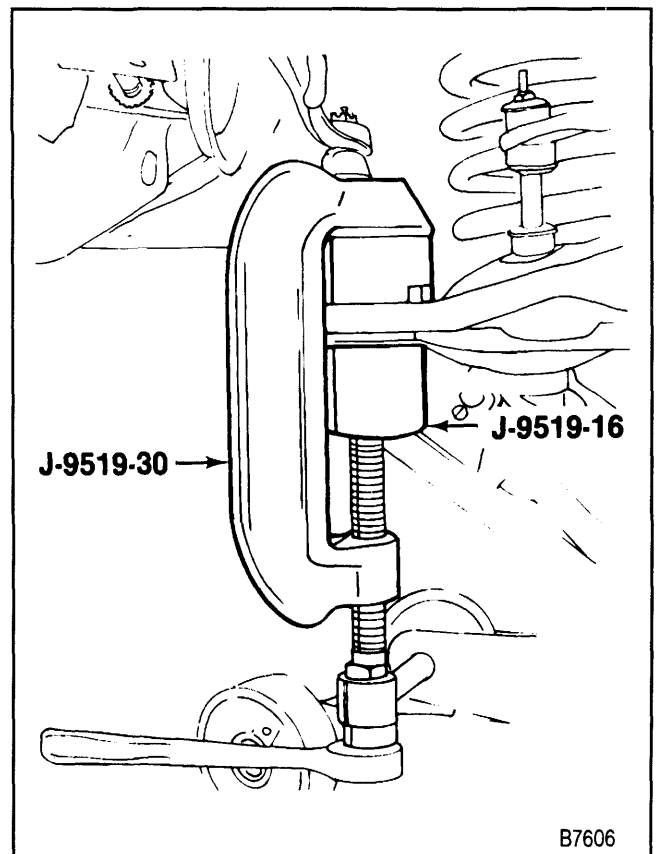


Figure 15—Installing the Lower Ball Joint

3C-14 FRONT SUSPENSION AND AXLE

UPPER BALL JOINT REPLACEMENT

- Raise the vehicle and support it with safety stands.
- Support the control arm with a jack.

CAUTION: Floor jack or stand must remain under the control arm spring seat during removal and installation to retain the spring and control arm in position or personal injury may result.

Remove or Disconnect (Figure 12)

Tool Required:

J 23742 Ball Joint Separator

1. Tire and wheel assembly.
2. Brake caliper. Refer to SECTION 5B1.

Important

- Support the caliper with a piece of wire to prevent damage to the brake line.
3. Rivets from the upper ball joint (66).
 - A. Use a 3.175 mm (1/8-inch) drill to cut a 6.35 mm (1/4-inch) deep hole in the center of each rivet (figure 16).
 - B. Drill the rivet heads away using a 12.7 mm (1/2-inch) drill (figure 17).
 - C. Punch the rivets out using a small pin punch (figure 18).
 4. Cotter pin (68).
 5. Stud nut (67) from the upper ball joint (66).
 - A. Use J 23742 as shown in figure 19.
 - B. Apply pressure on the tool until the stud breaks loose.
 - C. Remove J 23742.
 - D. Pull the stud away from the knuckle.
 - E. Support the knuckle assembly so that its weight will not damage the brake hose.
 6. Upper ball joint (66).

Install or Connect (Figure 12 and 20)

NOTICE: For steps 1 and 3, refer to "Notice" on page 3C-1.

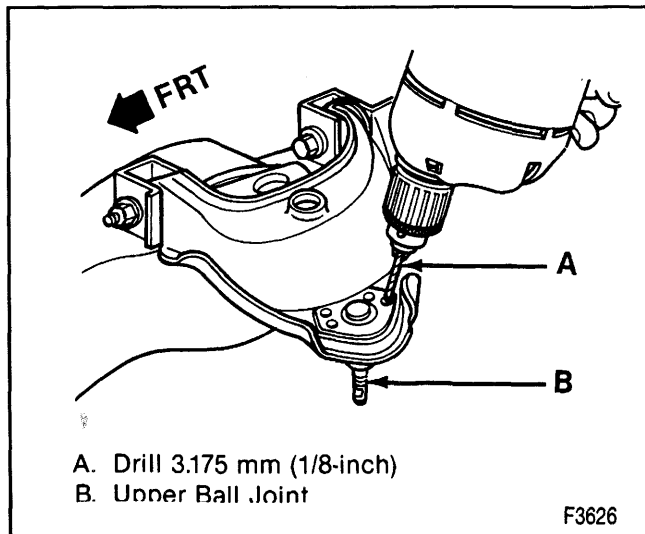


Figure 16—Drilling the Upper Ball Joint Rivets

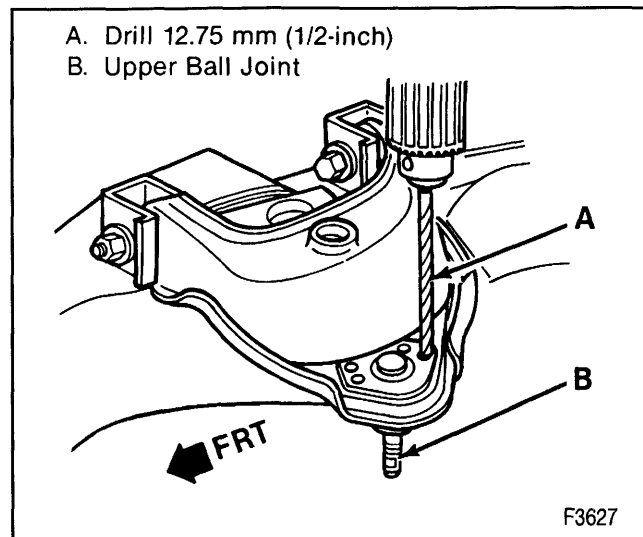


Figure 17—Drilling the Upper Ball Joint Rivet Heads

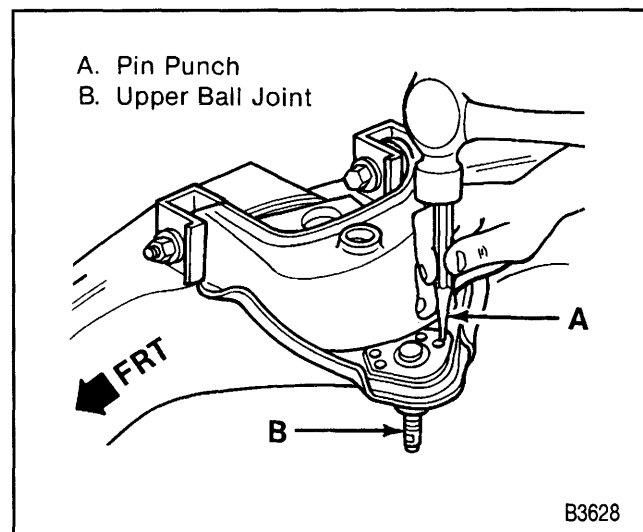


Figure 18—Removing the Upper Ball Joint Rivets

1. New upper ball joint (66) to the upper control arm (42) (figure 20).

- Position four attaching bolts and nuts (figure 20).

Tighten

- Nuts (A) to 24 N.m (18 lbs. ft.).
- Take the support away from the knuckle assembly.

2. Upper ball joint (66) to the steering knuckle.
3. Stud nut (67).

Tighten

- Nut (67) to 115 N.m (84 lbs. ft.).
- Align the slot in the stud nut with the hole in the stud by tightening the stud nut.

4. New cotter pin (68).
5. Brake caliper. Refer to SECTION 5B1.

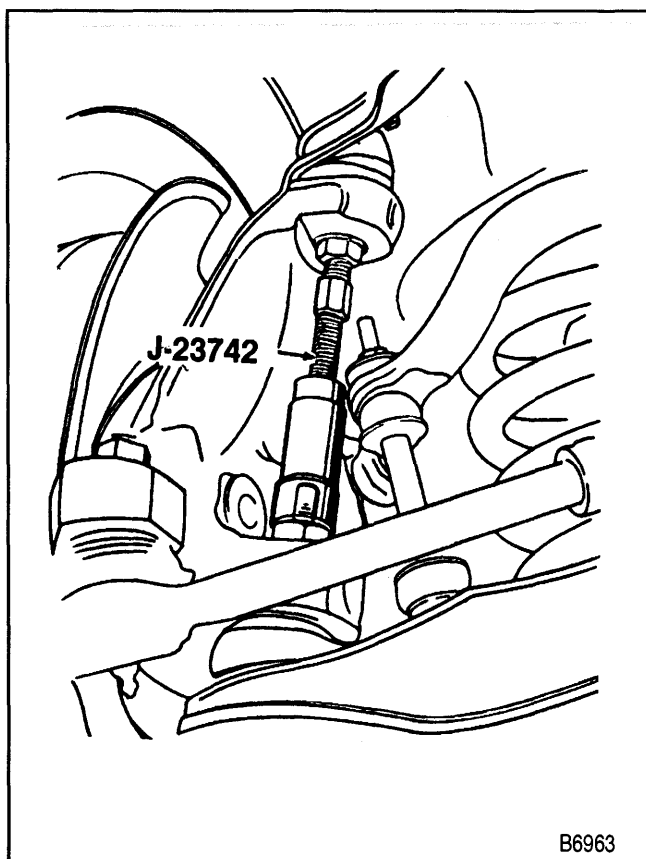


Figure 19—Disconnecting the Upper Ball Joint

6. Tire and wheel assembly.

- Lower the vehicle.

! Important

- Check the running clearance at all suspension components.
- Check the front end alignment. Refer to SECTION 3A.

STEERING KNUCKLE REPLACEMENT

↔ Remove or Disconnect (Figure 7, 21, and 22)

Tool Required:

J 23742 Ball Joint Separator

- Raise the front of the vehicle and place floor stands under the front lift points. Do not place the floor stands under the lower control arms because spring tension is needed to assist in breaking loose the ball joint studs.

1. Tire and wheel assembly.
2. Tie rod from the steering knuckle. Refer to SECTION 3B3.
3. Brake caliper. Refer to SECTION 5B1.

! Important

- Support the caliper with a piece of wire to prevent damage to the brake line.

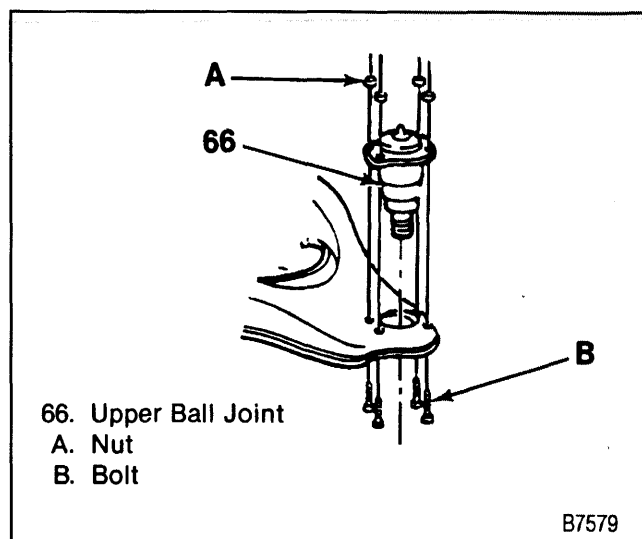


Figure 20—Installing the Upper Ball Joint

4. Hub/rotor assembly (17). Refer to "Hub, Bearing and Seal Replacement."
5. Three bolts attaching the splash shield to the knuckle (23) (figure 21).
6. Knuckle seal (20) if the knuckle (23) is to be replaced.

- Be careful not to damage the knuckle seal (20).

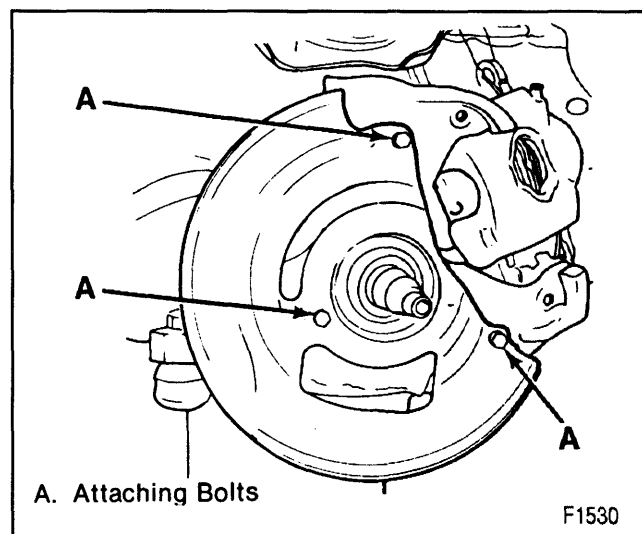


Figure 21—Splash Shield Attachment

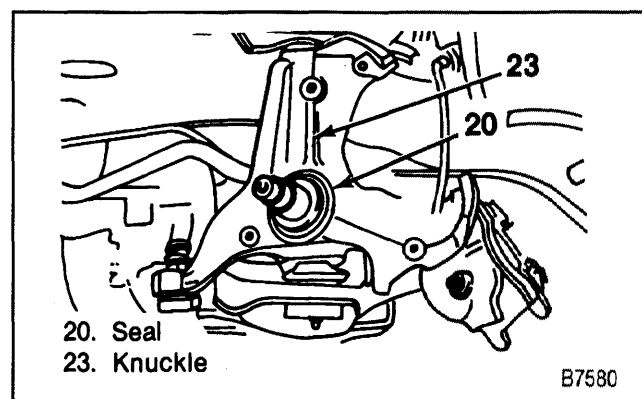


Figure 22—Locating the Seal on the Knuckle

3C-16 FRONT SUSPENSION AND AXLE

7. Ball studs from the knuckle (23) using J 23742 (figure 19).
 - Refer to ball joint replacement procedures in this section.

CAUTION: Floor jack must remain under control arm spring seat during removal and installation to retain the spring and control arm in position or personal injury may result.

- Position a floor jack under the lower control arm near the spring seat. Raise the jack until it just supports the lower control arm.
- Raise the upper control arm and disengage the ball joint stud from the knuckle (23).

8. Knuckle (23) from the lower ball joint stud.



Clean

- The steering knuckle.



Inspect

- Steering knuckle tapered hole. If out-of-round, deformed or damaged, the knuckle must be replaced.



Install or Connect (Figure 7, 21, and 22)

1. Upper and lower ball joints into the knuckle (23). Refer to "Ball Joint Replacement."
2. Knuckle seal (20) (figure 22).
3. Splash shield (25) to the knuckle (23).

NOTICE: Refer to "Notice" on page 3C-1.

4. Bolts (A) to the splash shield (25) (figure 21).



Tighten

- Bolts (A) to 26 N.m (19 lbs. ft.).
5. Tie rod end into the knuckle (23). Refer to SECTION 3B3.
 6. Hub/rotor assembly (17). Refer to "Hub, Bearing and Seal Replacement."
 - Adjust the wheel bearing. Refer to "Wheel Bearing Adjustment."
 7. Tire and wheel assembly.
 8. Floor stands.
 - Lower the vehicle.
 - Check front end alignment. Refer to SECTION 3A.

COIL SPRING REPLACEMENT



Remove or Disconnect (Figure 12, 23, and 24)

Tool Required:

J 23028-01 Coil Spring Remover and Installer

- Raise the vehicle on a hoist so that the control arms hang free.

1. Tire and wheel.
2. Shock absorber. Refer to "Shock Absorber Replacement."

- Cradle the lower control arm using J 23028-01 secured to the end of a suitable jack (figure 23).
3. Stabilizer shaft from the lower control arm (figure 11).
 - Raise the jack to remove tension on the lower control arm pivot bolts (72 and 77).
 - Secure the spring with a chain through the spring and the control arm.
 4. Pivot bolts (72 and 77) and nuts (71 and 78).
 - Take the rear pivot bolt (72) out first.
 - Lower the control arm (40) by lowering the jack.
 - When compression is removed from the coil spring, take the chain away.



Important

- Do not force the lower control arm and ball joint in order to remove the coil spring.
5. Coil spring (37) and the insulator (73).
 - Position the coil spring properly for easy removal.



Install or Connect (Figure 12, 23, and 24)

Tool Required:

J 23028-01 Coil Spring Remover and Installer

1. Coil spring (37) and the insulator (73) on the lower control arm (40) (figure 24).
 - Secure the spring with a chain through the spring and the control arm.
 - Be sure the spring insulator is on top.
 - Use J 23028-01 to support the control arm (figure 23).
2. The lower control arm (40) in place on the frame.
 - Guide the control arm into place with a pry bar.

NOTICE: Refer to "Notice" on page 3C-1.

3. Pivot bolts (72 and 77) and new nuts (71 and 78).
 - Insert and tighten the front bolt (72) first.
 - Remove the chain and the jack.



Important

- Refer to mandatory bolt direction of installation in (figure 25).

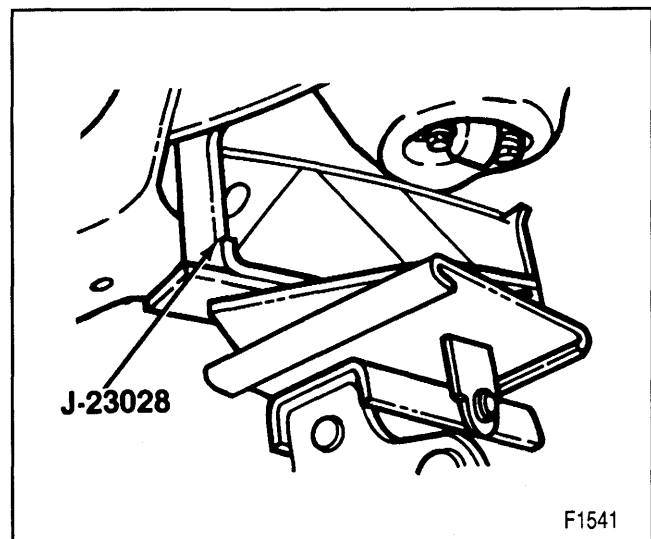


Figure 23—Cradling the Lower Control Arm



Tighten

- Nuts (78 and 71) to 165 N.m (121 lbs. ft.).
 - Front nut (78) must be tightened before the rear nut (71).
 - The nuts (78 and 71) must be tightened with the control arm at "Z" Height. Refer to SECTION 3A.
4. Stabilizer shaft, if used. Refer to "Stabilizer Shaft Replacement."
 5. Shock absorber. Refer to "Shock Absorber Replacement."
 6. Tire and wheel.
- Lower the vehicle.

UPPER CONTROL ARM AND BUSHING REPLACEMENT



Remove or Disconnect (Figures 12 and 26)

- The bushings in the C1,2 series control arms are welded in place and are not serviceable.
- Raise the front of the vehicle and support the lower control arm with floor stands. Since the weight of the vehicle is used to relieve the spring tension on the upper control arm, the floor stands must be positioned between the spring seats and the ball joints of the lower control arms for maximum leverage.

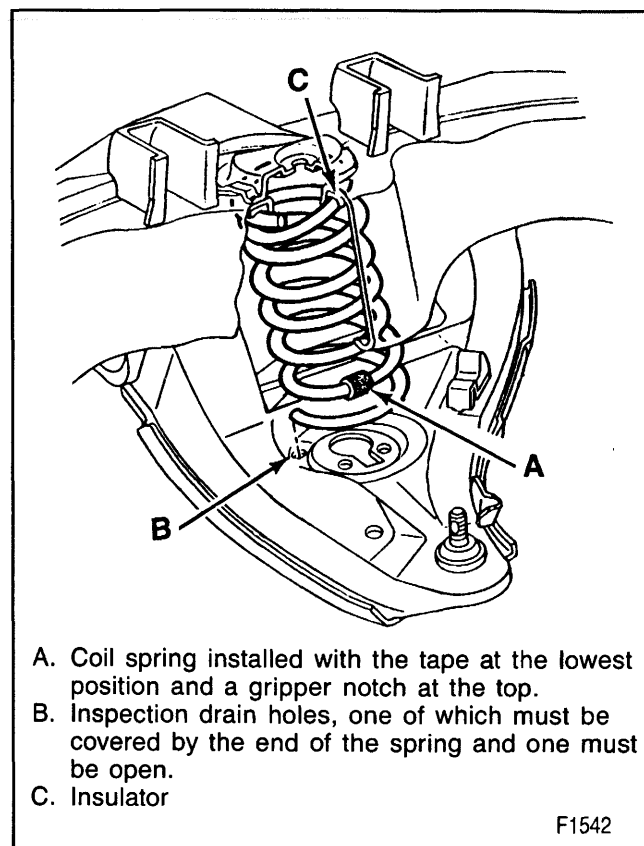


Figure 24—Positioning the Coil Spring

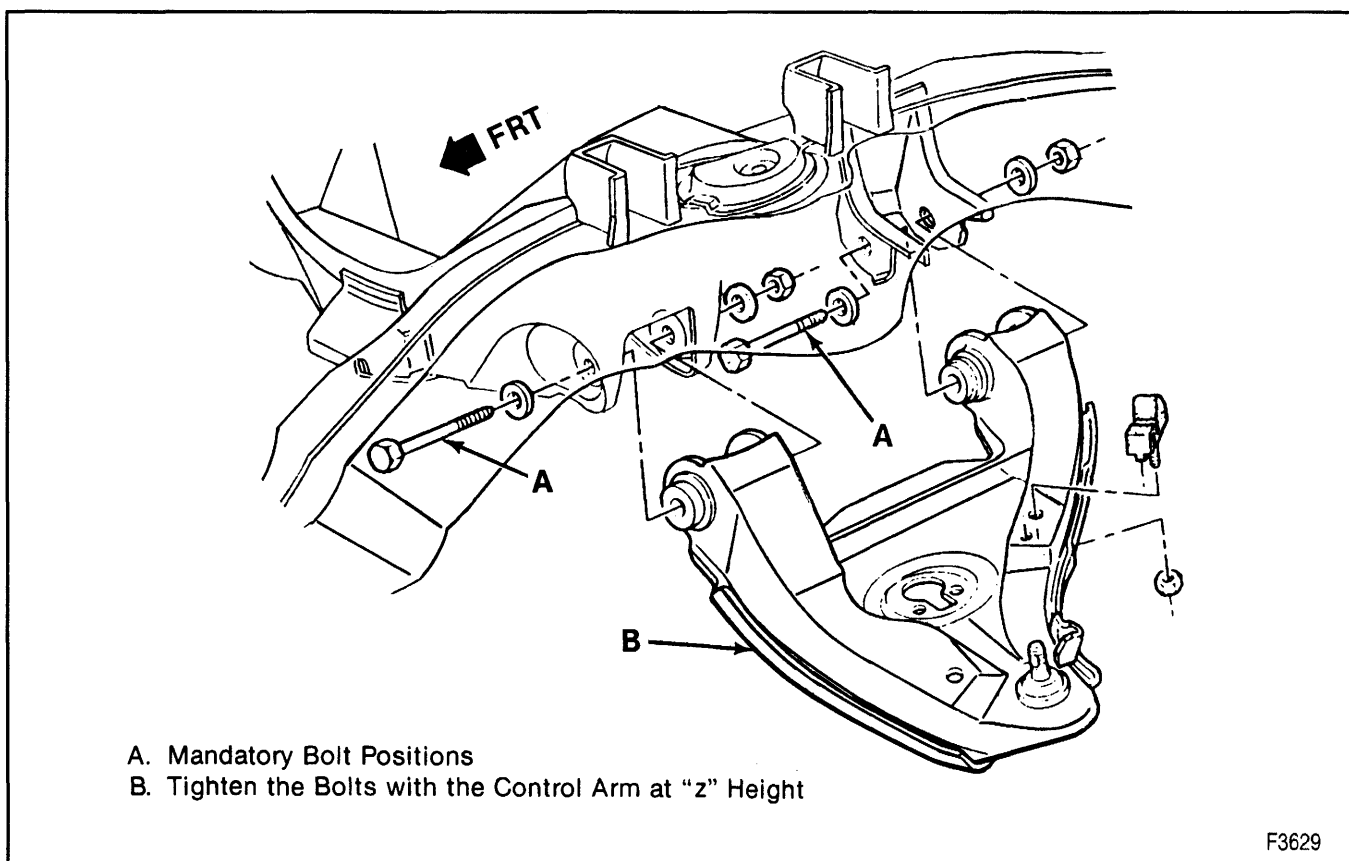
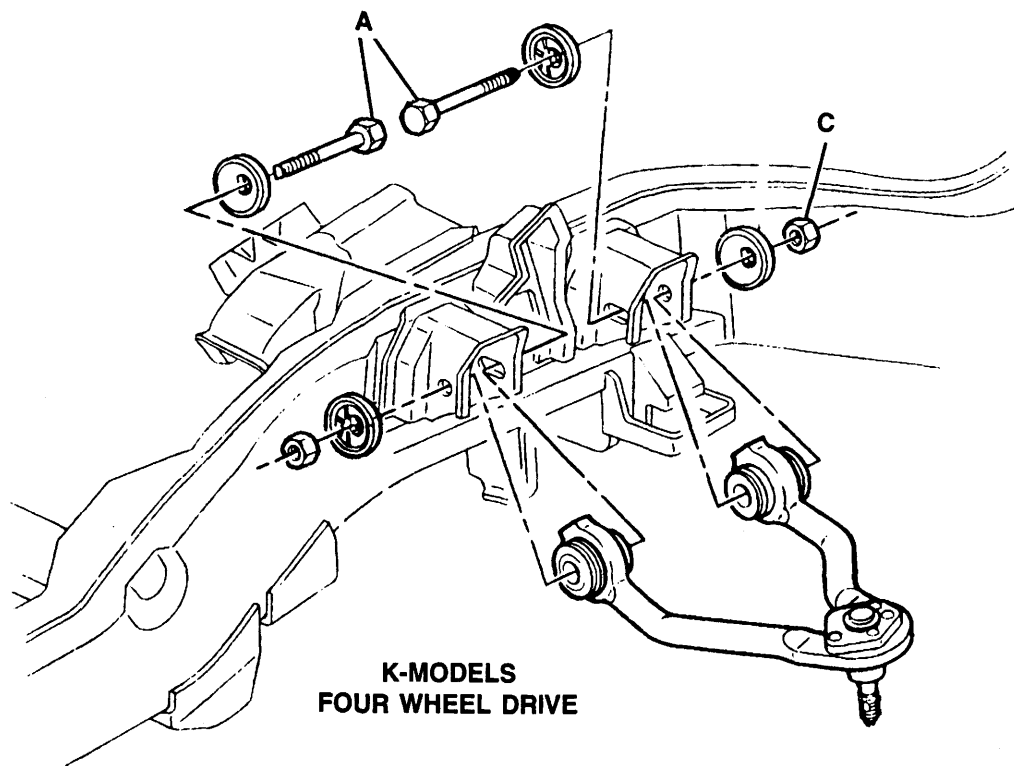
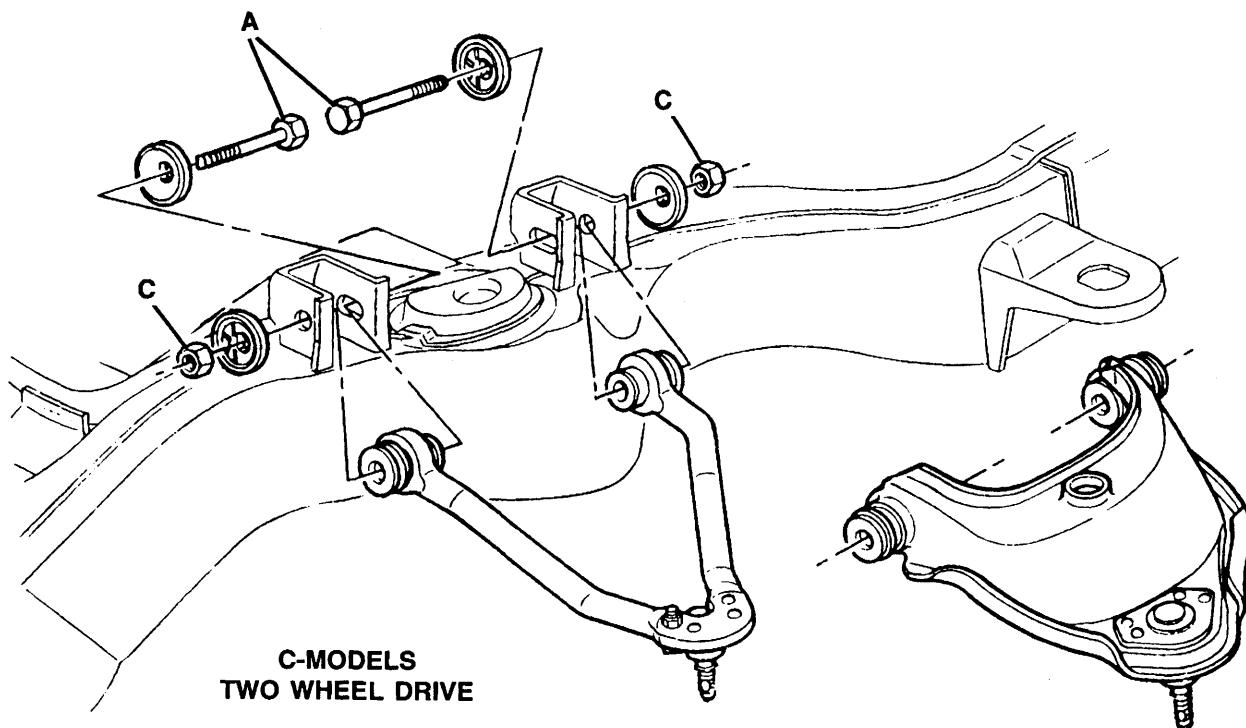


Figure 25—Installing the Lower Control Arm

3C-18 FRONT SUSPENSION AND AXLE



- A. MANDATORY BOLT POSITION
- B. ASSEMBLE AND ALIGN PRIOR TO TIGHTENING
- C. TIGHTEN FRONT NUT PRIOR TO TIGHTENING
REAR NUT 190 N·m (140 FT. LBS.)

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Figure 26—Installing the Upper Control Arm

CAUTION: The floor jack must remain under the control arm spring seat during removal and installation to retain the spring and control arm in position or personal injury may result.

1. Tire and wheel assembly.
2. Air cleaner extension, if needed.
3. Brake hose.
 - Nuts (85) and bolts (87).
 - Bracket (86) and the hose.
 - Tie the hose out of the way.
4. Upper ball joint from the steering knuckle. Refer to "Upper Ball Joint Replacement."
5. Upper control arm attaching bolts (79) and nuts (80).
6. Upper control arm (42).
7. Bushings (84).



Inspect

- All parts for wear and damage.



Install or Connect (Figure 12 and 26)

1. Bushings (84).
2. Upper control arm (40) to the frame.

NOTICE: Refer to "Notice" on page 3C-1.

3. Screws (79) and new nuts (80).



Important

- Refer to mandatory bolt direction in (figure 26).
- Tighten front nut prior to tightening rear nut.



Tighten

- Nuts (80) to 190 N.m (140 lbs. ft.).
 - The nuts (80) must be tightened with the control arm at "Z" Height. Refer to SECTION 3A.
4. Upper ball joint to the steering knuckle. Refer to "Upper Ball Joint Replacement."

5. Brake hose.
 - Bracket (86) to the control arm.
 - Screws (87) and the nuts (85).
6. Air cleaner extension, if needed.
7. Tire and wheel assembly.
 - Check front end alignment. Refer to SECTION 3A.

LOWER CONTROL ARM AND BUSHING REPLACEMENT



Remove or Disconnect (Figure 12 and 25)

Tool Required:

J 23742 Ball Joint Separator

1. Cotter pin (68) and the nut (85).
 - Separate the ball joint using J 23742 (figure 13).
2. Control arm (40) from the knuckle.
3. Coil spring. Refer to "Coil Spring Replacement."
4. Nuts (78) and (71) from bolts (77) and (72).
5. Bolts (77) and (72) from lower control arm.
6. Lower control arm (40).
7. Bushings (75 and 76).



Install or Connect (Figure 12 and 25)

NOTICE: For steps 4 and 7, Refer to "Notice" on page 3C-1.

1. Bushings (75 and 76).
2. Control arm (40) to frame.
3. Bolts (72) and (77).
4. Nuts (71) and (78).
5. Coil spring. Refer to "Coil Spring Replacement."
6. Control arm (40) to steering knuckle.
7. Nut (85).



Tighten

- Nuts (71) and (78) to 165 N.m (121 lbs. ft.).
 - Nut (67) to 115 N.m (84 lbs. ft.) and align the slot in the stud nut with the hole in the stud by tightening.
8. New cotter pin (68).

ON-VEHICLE SERVICE: FOUR-WHEEL DRIVE FRONT SUSPENSION

SHOCK ABSORBER REPLACEMENT



Remove or Disconnect (Figure 27)

NOTICE: Original equipment shock absorbers serve additionally as suspension drop cut-offs. Replacement shock absorbers must have a built in suspension cutoff feature and must not be longer than original shocks when they are fully extended or serious vehicle or component damage could result.



Install or Connect (Figure 27)

1. Shock absorber (91) to the bracket.
2. Bolts (94 and 96).
 - Fit the bolts (94 and 96) in the direction shown in figure 27.

NOTICE: Refer to "Notice" on page 3C-1.

3C-20 FRONT SUSPENSION AND AXLE

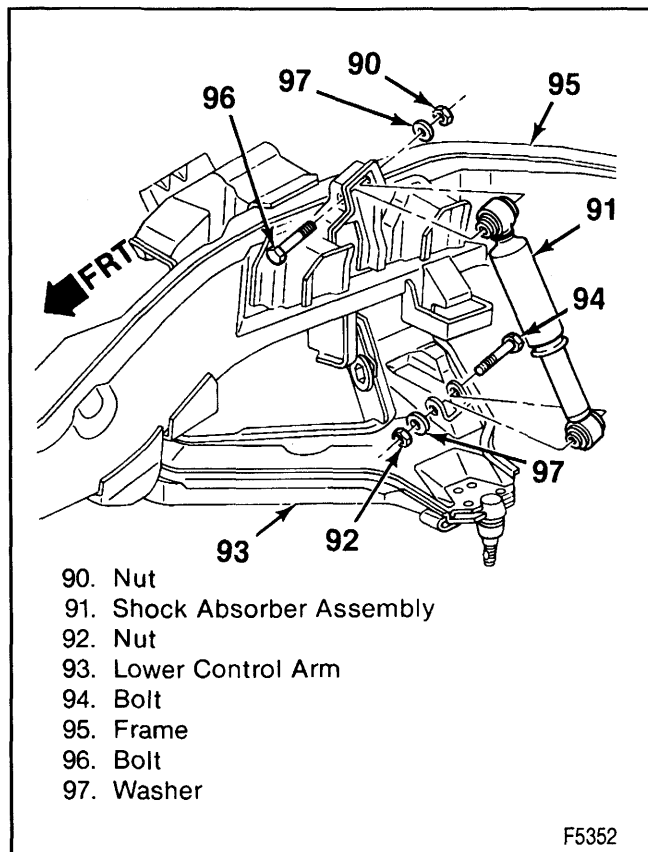


Figure 27—Shock Absorber Attachment

3. New nuts (90 and 92) to the bolts (94 and 96).



Tighten

- Nuts (90 and 92) to 90 N.m (66 lbs. ft.).

STABILIZER SHAFT REPLACEMENT



Remove or Disconnect (Figure 28)

- Raise the vehicle and support it with suitable safety stands.



Important

- Be sure to remove parts from the right and left front of the vehicle and keep them separated.

1. Nuts (103).
2. Bolts (105).
3. Spacers (104).
4. Bolts (109).
5. Clamp (108).
6. Stabilizer shaft (107).
7. Insulators (110).



Inspect

- All parts for wear and damage.

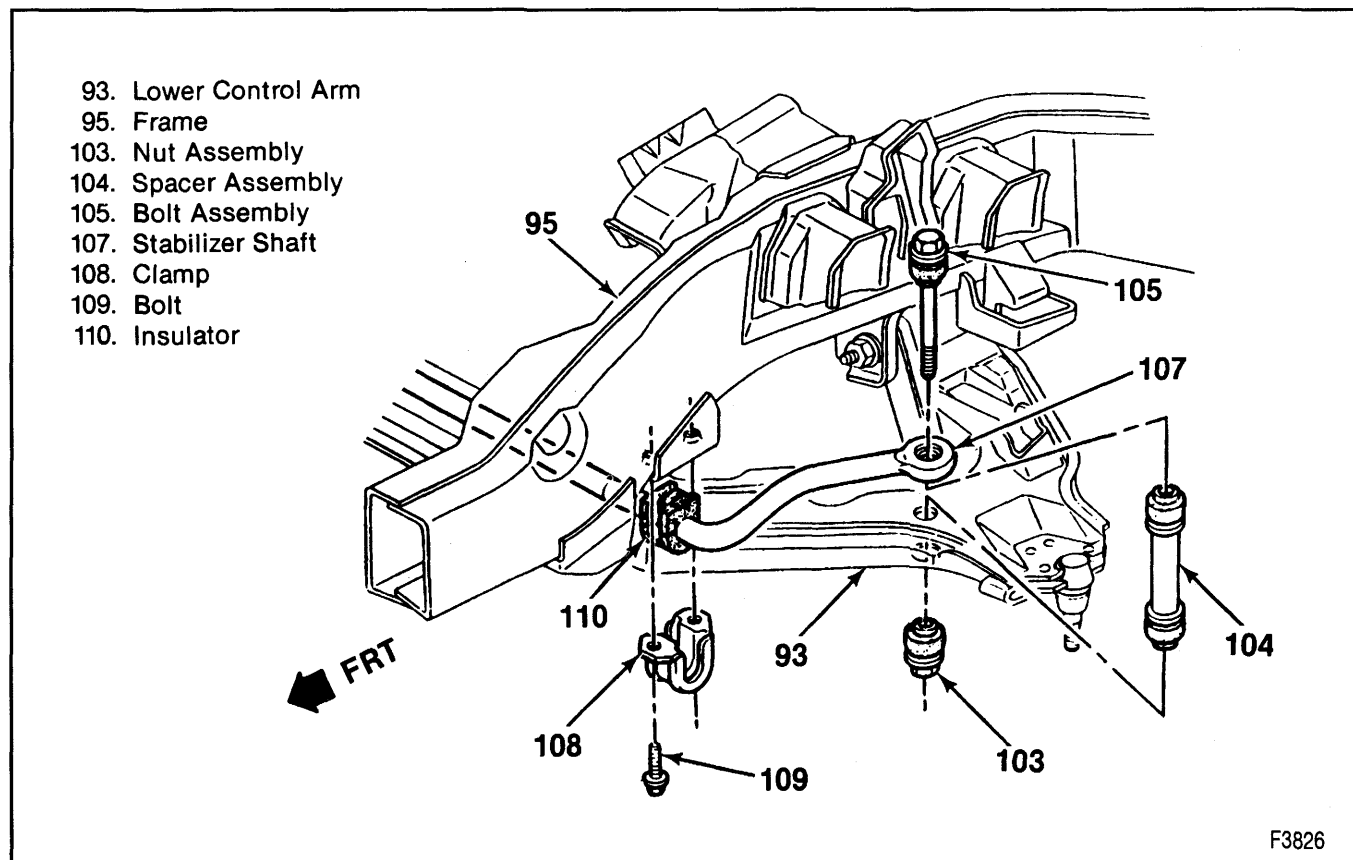


Figure 28—Stabilizer Shaft Components

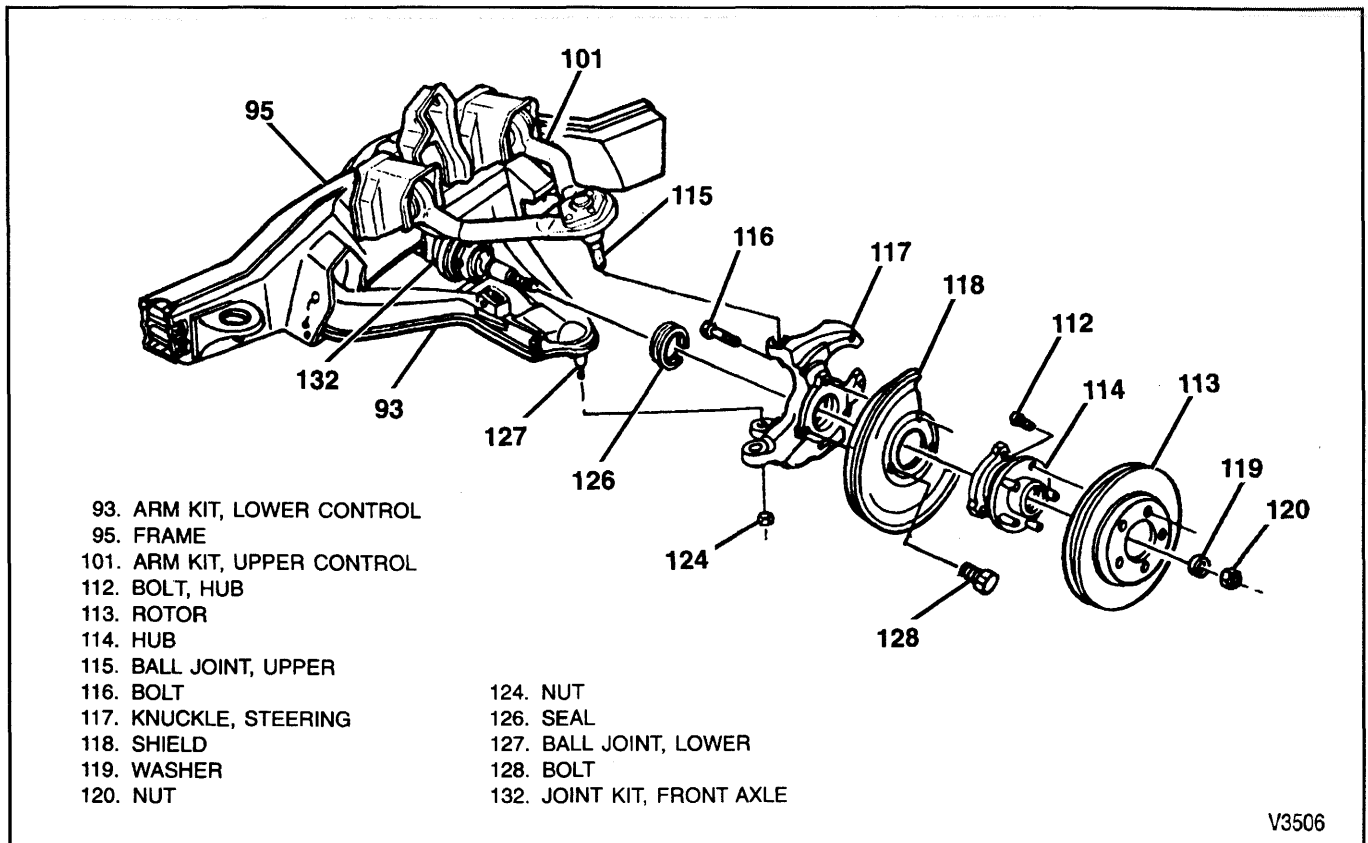


Figure 29—Hub, Knuckle, and Control Arm Components

Install or Connect (Figure 28)

NOTICE: For steps 4 and 7, refer to "Notice" on page 3C-1.

- Unload the torsion bar. Refer to "Torsion Bar(s) and Support Assembly Replacement."
- 1. Insulators (110) to the stabilizer shaft (107).
 - Be sure the slit in the insulator (110) faces forward.
- 2. Stabilizer shaft (107) to the frame and lower control arm (93).
- 3. Clamp (108) to the insulator (110).
- 4. Bolts (109) to the frame (95).

Tighten

- Bolts (109) to 17 N·m (12 lbs. ft.).
- 5. Spacers (104).
- 6. Link bolts (105).
- 7. Nuts (103).

Tighten

- Nuts (103) to 18 N·m (13 lbs. ft.).
- Lower the vehicle.

Important

- Adjust the trim height of the vehicle. Refer to SECTION 3A.

ROTOR REPLACEMENT

(K-1, K-2 MODELS)

Remove or Disconnect (Figure 29)

- Raise the vehicle and support it with suitable safety stands.
- 1. Tire and wheel.
- 2. Brake caliper. Refer to SECTION 5B1.
- 3. Rotor (113).

Inspect

- All parts. Replace as necessary.

Install or Connect (Figure 29)

1. Rotor (113) to the hub and bearing assembly.
2. Brake caliper. Refer to SECTION 5B1.
3. Tire and wheel.
- Lower the vehicle.
- Depress the brake pedal.

(K-3 MODELS)

Remove or Disconnect (Figure 29 through 33)

- Raise the vehicle and support it with suitable safety stands.
- 1. Tire and wheel.
- 2. Brake caliper. Refer to SECTION 5B1.
- 3. Nut (120)
- 4. Hub/rotor retaining bolts (21). (figure 30).
- 5. Using wheel puller, remove rotor assembly (20).

3C-22 FRONT SUSPENSION AND AXLE

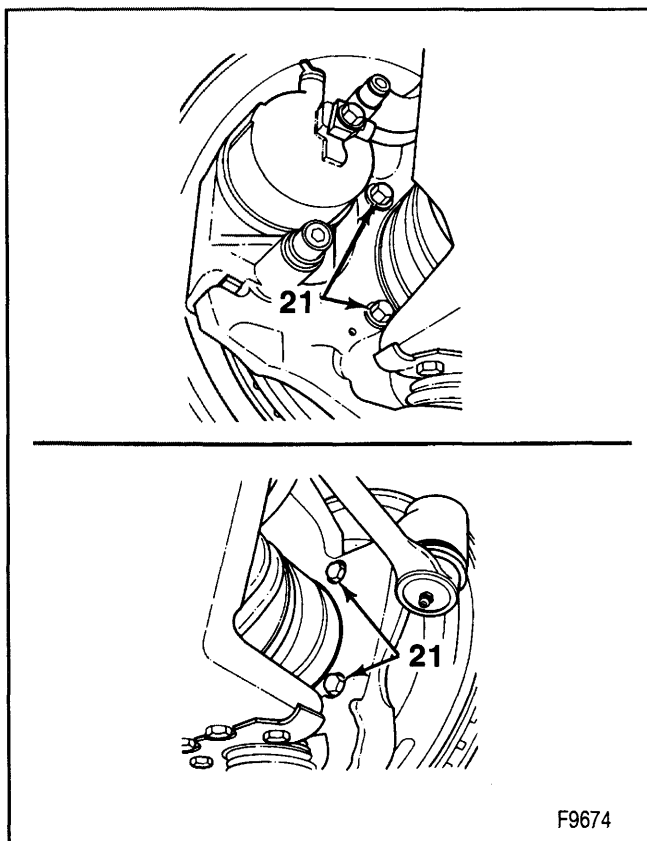


Figure 30—Removing Rotor Retaining Bolts (K-3)

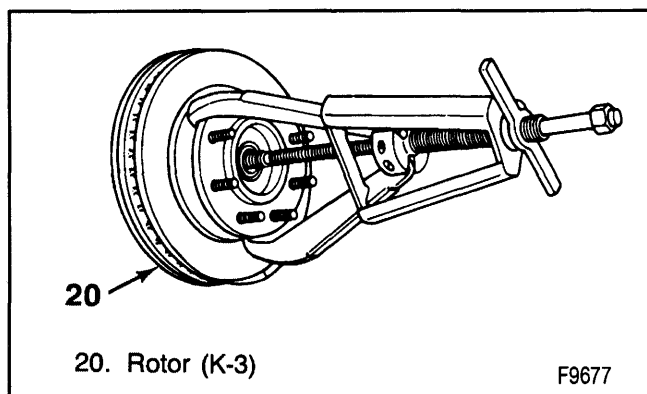


Figure 31—Removing Rotor from the Spindle (K-3)

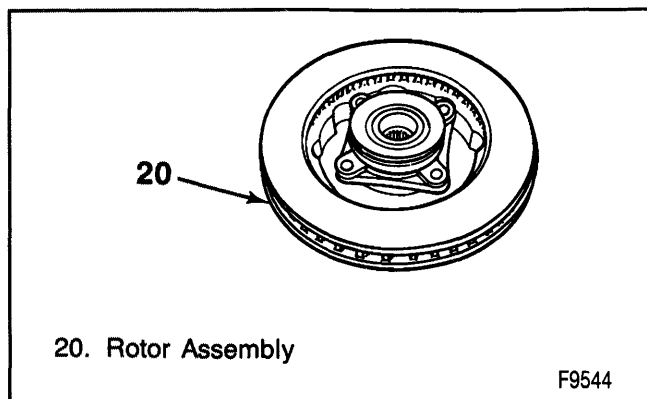


Figure 32—Rotor Assembly (K-3)

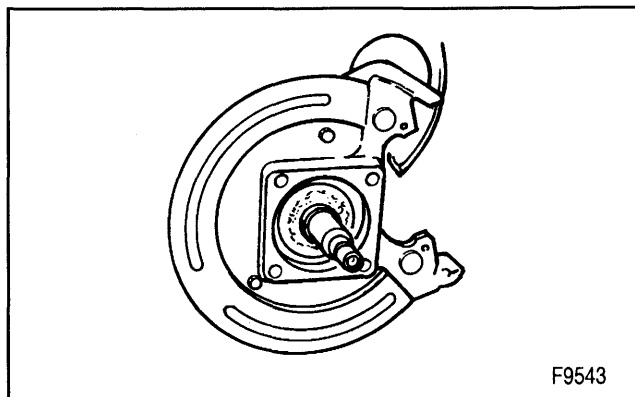


Figure 33—Front Axle Assembly (K-3)



Inspect

- All parts. Replace as necessary.



Install or Connect (Figure 30 through 33)

1. Hub/rotor (20) to the hub and bearing assembly.
2. Rotor and hub assembly to axle.

NOTICE: Refer to "Notice" on page 3C-1.



Tighten

- Bolts (21) 180 N.m (133 lbs. ft.).
 - Nut (120) 235 N.m (173 lbs. ft.).
3. Brake caliper. Refer to SECTION 5B1.
 4. Tire and wheel.
 - Lower the vehicle.
 - Depress the brake pedal.

WHEEL HUB BOLT REPLACEMENT



Remove or Disconnect (Figure 34)

Tool Required:

J 6627-A Tie Rod End Puller

- Raise the vehicle and support it with suitable safety stands.

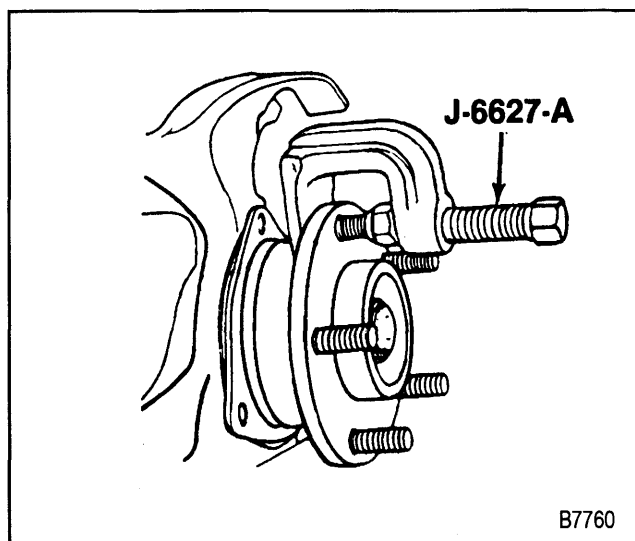


Figure 34—Removing the Wheel Hub Bolts

1. Tire and wheel.
2. Brake caliper. Refer to SECTION 5B1.

! Important

- Support the caliper with a piece of wire to prevent damage to the brake line.
3. Stud (112) using J 6627-A (figure 33).
 - Do not hammer on a wheel stud.

↔ Install or Connect (Figure 35)

1. Stud (112) to the hub and bearing assembly.
2. Washers (A) and nut (B) to the stud (figure 34).

⌚ Tighten

- Nut (B). Draw the stud in.
 - Remove the nut and washers.
3. Brake caliper. Refer to SECTION 5B1.
 4. Tire and wheel.
 - Lower the vehicle.

HUB AND BEARING, KNUCKLE AND SEAL ASSEMBLY REPLACEMENT

↔ Remove or Disconnect (Figures 29 and 36)

Tool Required:

J 36607 Ball Joint Separator

- Raise the vehicle and support with suitable safety stands.
1. Tire and wheel.
 - Install a cover on the axle joint (132) (figure 36).
2. Brake caliper. Refer to SECTION 5B1.

! Important

- Support the caliper with a piece of wire to prevent damage to the brake line.
3. Brake rotor. Refer to "Rotor Replacement."
 4. Drive axle nut (120).
 5. Washer (119).
 6. Tie rod nut (124).

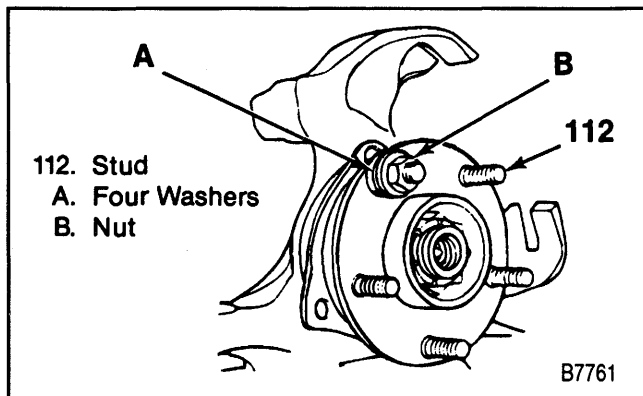


Figure 35—Installing the Wheel Hub Bolts

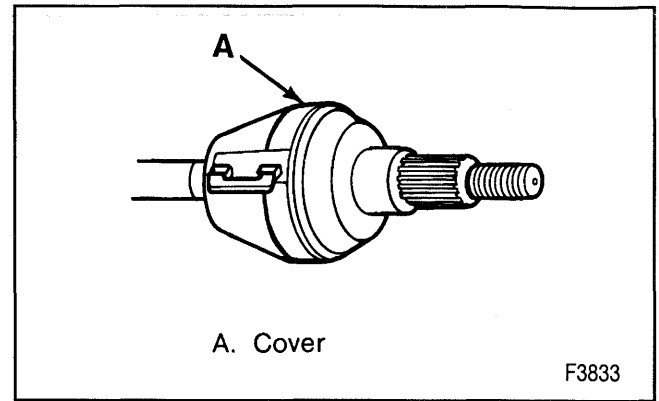


Figure 36—Drive Axle Cover Installed

7. Tie rod end (125) from the knuckle (117). Refer to SECTION 3B3.
8. Hub and bearing assembly (114), using a puller.

! Important

- Lay the hub and bearing assembly on the hub bolt (outboard) side. This will prevent damage or contamination of the bearing seal.
9. Drive axle. Refer to SECTION 4C.
 10. Splash shield bolts (128).
 11. Splash shield (118).
 - Support the lower control arm with a jack stand.
 12. Upper ball joint nut (129).
 13. Upper ball joint (115) from the knuckle (117).
 14. Lower ball joint nut (131).
 15. Lower ball joint (127) from the knuckle (117).
 16. Knuckle (117).
 17. Seal from the knuckle.

↔ Install or Connect (Figures 29 and 36)

NOTICE: For steps 3, 6, 11, 13, and 17, refer to "Notice" on page 3C-1.

Tool Required:

J 36605 Steering Knuckle Seal Installer

1. Seal (126) into the knuckle (117) using J 36605.
2. Knuckle (117) to the upper and lower ball joints (115 and 127).
3. Nuts (129 and 131).

⌚ Tighten

- Nuts (129 and 131) to 115 N.m (84 lbs. ft.).
 - Tighten the nuts to align the cotter pin. Do not tighten more than 1/6 turn.
4. New cotter pins (130).
 - Bend the pin ends against the nut.
 5. Splash shield (118).
 - Be sure the splash shield is aligned properly.
 6. Splash shield bolts (128).

⌚ Tighten

- Bolts (128) to 26 N.m (19 lbs. ft.).
- Prelube steering knuckle seal.

3C-24 FRONT SUSPENSION AND AXLE

7. Drive axle. Refer to SECTION 4C.
8. Hub and bearing assembly (114).
 - Align the threaded holes.
9. Bolts (116).

Tighten

- Bolts (116) to 180 N.m (133 lbs. ft.).
10. Tie rod end (125) to the knuckle (117).
 11. Tie rod nut (124).

Tighten

- Nut (124) to 48 N.m (35 lbs. ft.).
12. Washer (119).
 13. Nut (120).

Tighten

- Nut (120) to 235 N.m (173 lbs. ft.).
14. Brake rotor. Refer to "Rotor Replacement."
 15. Brake caliper. Refer to SECTION 5B1.
 - Remove the axle joint cover.
 16. Tire and wheel.
 17. Wheel nuts.

Tighten

- Wheel nuts (C/K-1,2,3 Single wheel) to 135 N.m (100 lbs. ft.).
- Wheel nuts (C/K-3 Dual wheel) to 170 N.m (125 lbs. ft.).
- Remove the jack stand.
- Lower the vehicle.
- Align the front end and check vehicle trim height. Refer to SECTION 3A.

UPPER BALL JOINT REPLACEMENT

Remove or Disconnect (Figures 29 and 37)

- Raise the vehicle and support it with suitable safety stands.
1. Tire and wheel.
 2. Rivets from the ball joint (115).
 - A. Brake hose and bracket (142), upper control arm only.
 - B. Use a 3.175 mm (1/8-inch) drill to cut a 6.35 mm (1/4-inch) deep hole in the center of each rivet (figure 16).
 - C. Drill the rivet heads away using a 12.7 mm (1/2-inch) drill (figure 17).
 - D. Using a pin punch remove the rivets (figure 18).
 3. Pin (130).
 4. Nut (129).
 5. Ball joint (115) from the knuckle (117).
 - Support the knuckle.
 6. Ball joint (115).

Install or Connect (Figures 29 and 37)

NOTICE: For steps 2 and 4, refer to "Notice" on 3C-1.

1. Ball joint (115) to the control arm.

2. Bolts (B) and nuts (A) to the ball joint (figure 37).

Tighten

- Nuts (A) to 23 N.m (17 lbs. ft.) for K1-2, and to 70 N.m (52 ft.lbs.) for K3
3. Ball joints (115) to the knuckle (117).
 4. Nut (129).

Tighten

- Nut (129) to 115 N.m (84 lbs. ft.).
 - Nut (129) must be tightened with the control arm at "Z" Height. Refer to SECTION 3A.
 - Tighten the nut to align the cotter pin. Do not tighten more than 1/6 turn.
5. New pin (130).
 - Bend the pin ends against the nut.
 - Lower the vehicle.
 - Check front end alignment. Refer to SECTION 3A.

LOWER BALL JOINT REPLACEMENT

Remove or Disconnect (Figure 29, 38, and 39)

Tools Required

- J 24319-01 Steering Linkage Puller
- J 36202 Torsion Bar Unloading Tool
- J 29193 Steering Linkage Installer

- Raise the vehicle and support it with suitable safety stands.

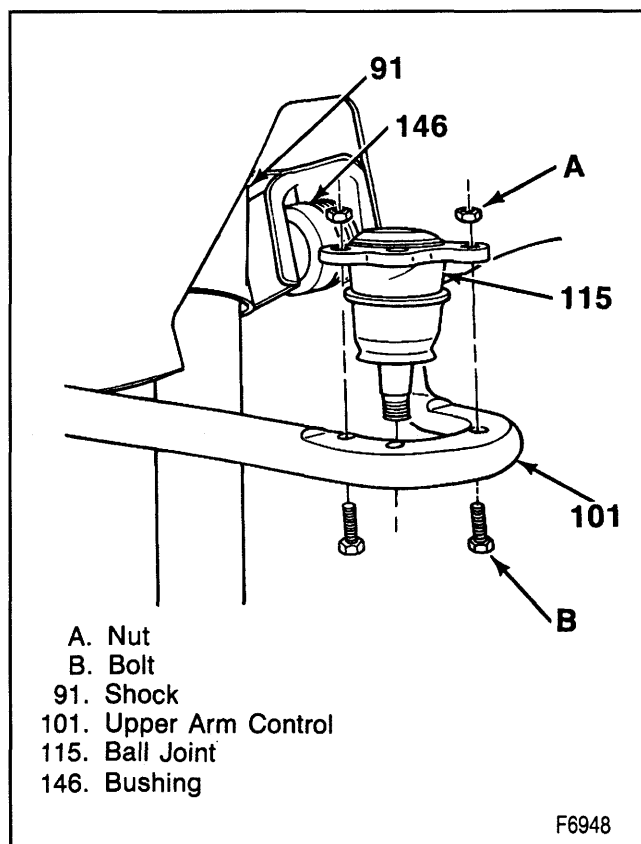


Figure 37—Installing the Upper Ball Joint

1. Tire and wheel.
2. Unload the torsion bar using tool J 36202 (figure 38).
 - Mark the adjuster bolt for reinstallation of the torsion bar. Refer to "Torsion Bars and Support Assembly Replacement."
3. Brake hose bracket.
4. Caliper and wire off to the side. Refer to SECTION 5B1.
 - Install the drive axle boot cover (figure 36).
5. Outer tie rod end (125) from the knuckle using J 24319-01.
6. Drive axle shaft nut (120) and washer (119) from the hub assembly.
 - Separate the shaft (132) from the splined hub (114).
7. Cotter pins (130) from upper and lower ball joint nuts.
 - Support the lower control arm assembly (93) with a jack.
8. Upper and lower ball joint nuts (129 and 131).
9. Separate the upper ball joint (115) from the knuckle (117) using J 36607.
10. Separate the lower ball joint (127) from the knuckle (117) using J 24319-01.
 - Using the support jack, remove the knuckle assembly.
11. Rivets
 - A. Center punch the bottom of the rivets.
 - B. Using a 3.175 mm (1/8-inch) drill bit, drill a guide hole 6.35 mm (1/4-inch) into the center of each rivet heads.

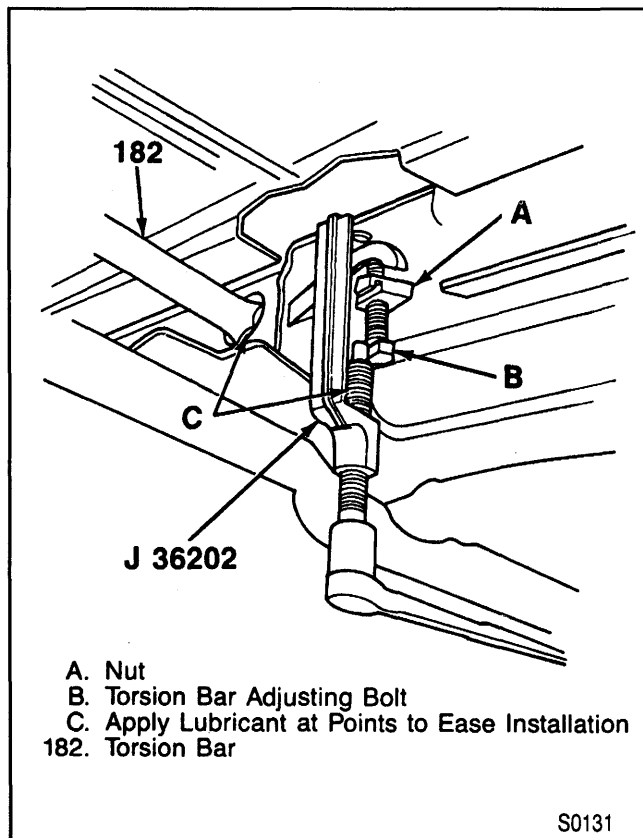


Figure 38—Removing or Installing the Torsion Bar Adjusting Bolt

- C. Using an 12.7 mm (1/2-inch) drill bit, drill the rivet head off.
- D. Drill a hole two-thirds the length of the rivet shank, using a 8 mm (5/16-inch) drill.
- E. Using an 8 mm (5/16-inch) pin punch, punch out the rivets.



Install or Connect

NOTICE: For steps 2, 4, 8, 10, and 12, refer to "Notice" on page 3C-1.

Tool Required:

J 36202 Torsion Bar Unloading Tool

1. Ball joint (127) to the control arm.
2. Bolts (137) and nuts (136) to the ball joint (127).



Tighten

- Nuts (136) to 60 N.m (45 lbs. ft.).
3. Knuckle to the upper ball joint.
 - Raise lower control arm with the hydraulic jack.
 4. Nut (131).



Tighten

- A. Nut to 128 N.m (94 ft.lbs.).
 - B. Nut must be tightened with the control arm at the "Z" height. Refer to SECTION 3A.
 - C. Tighten the nut to align the cotter pin. Do not tighten more than 1/6 turn.
5. New cotter pin (130).
 - Bend the pin ends against the nut.
 6. Load the torsion bar, using J 36202.
 - Set the adjuster bolt at the mark made during disassembly.
 7. Drive axle assembly (121) to the differential output shaft.
 8. Bolts (135).



Tighten

- Bolts to 78 N.m (57 lbs. ft.).
 - Prelube steering knuckle seal.
9. Drive axle to the hub (114).
 10. Washer (119 and nut (120).

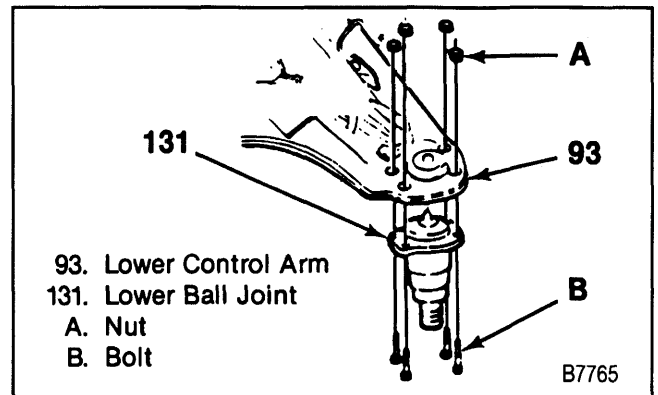


Figure 39—Installing the Lower Ball Joint

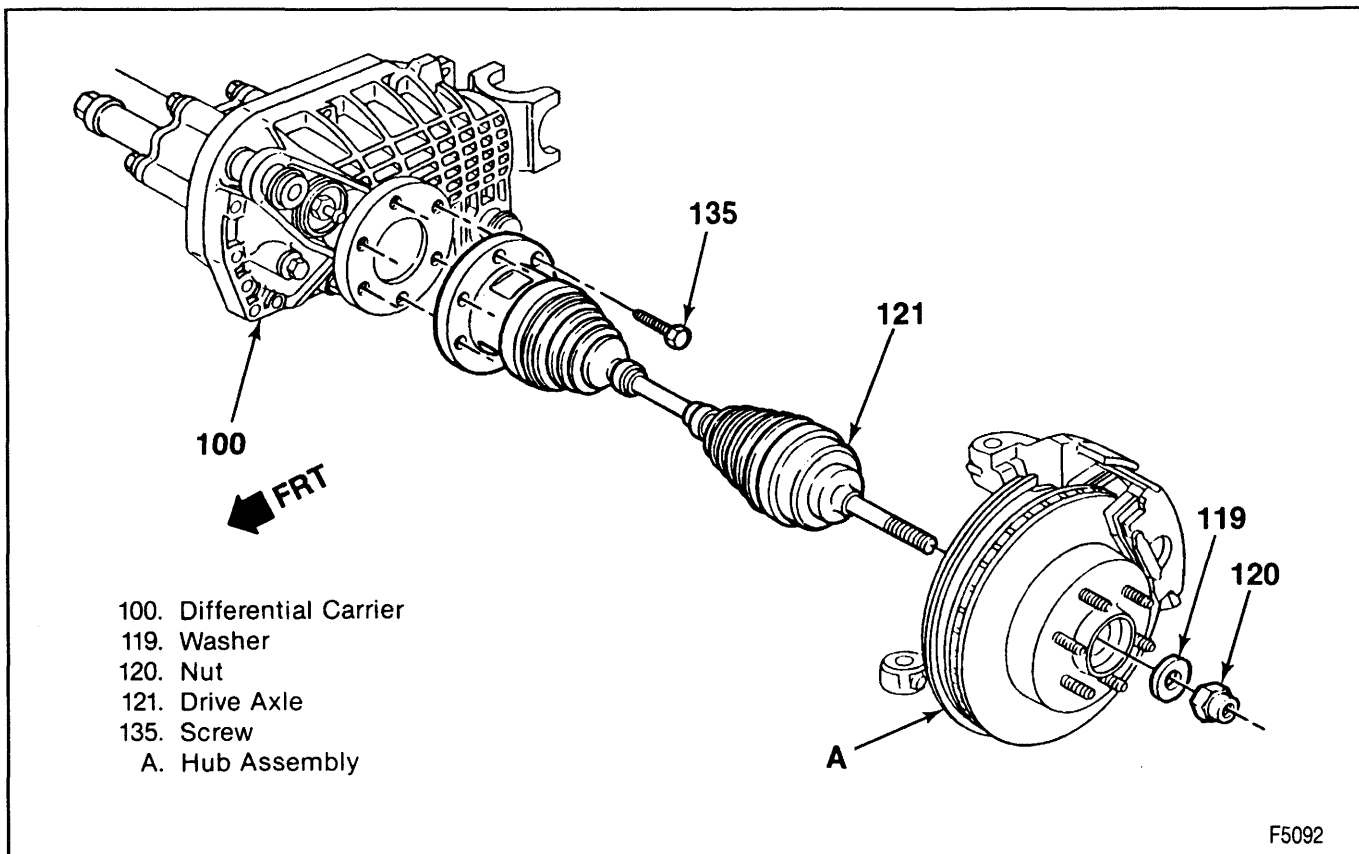


Figure 40—Drive Axle



Tighten

- Nut to 235 N.m (173 lbs. ft.).
- 11. Inner tie rod end to the relay rod.
- 12. Inner tie rod end nut.



Tighten

- Nut to 47 N.m (35 lbs. ft.).
- 13. Front splash shield.
- 14. Front splash shield bolts.
- 15. Tire and wheel.
- 16. Wheel nuts.
 - Lower the vehicle.
 - Check the front end alignment. Refer to SECTION 3A.

UPPER CONTROL ARM AND BUSHING REPLACEMENT



Remove or Disconnect (Figure 29 and 41)

- Raise the vehicle and support it with suitable safety stands.
- 1. Tire and wheel.
- 2. Air cleaner extension, if needed.
- 3. Brake hose.
 - Nut (141) and the screw (143).
 - Bracket (142) and the hose.
 - Tie the hose out of the way.
- 4. Cotter pin.
- 5. Nut (129).

- 6. Upper control arm (101) from the knuckle (117).
- 7. Nuts (145).
- 8. Bolts (140).
- 9. Upper control arm (101).
- 10. Bushings (146).

NOTICE: For steps 4 and 6, refer to "Notice" on page 3C-1.



Install or Connect (Figure 29 and 41)

- 1. Bushings (146).
- 2. Upper control arm (101) to the frame (95).
- 3. Bolts (140) and the washers.
 - Be sure the bolt heads are opposed inside the bracket.
- 4. New nuts (145).



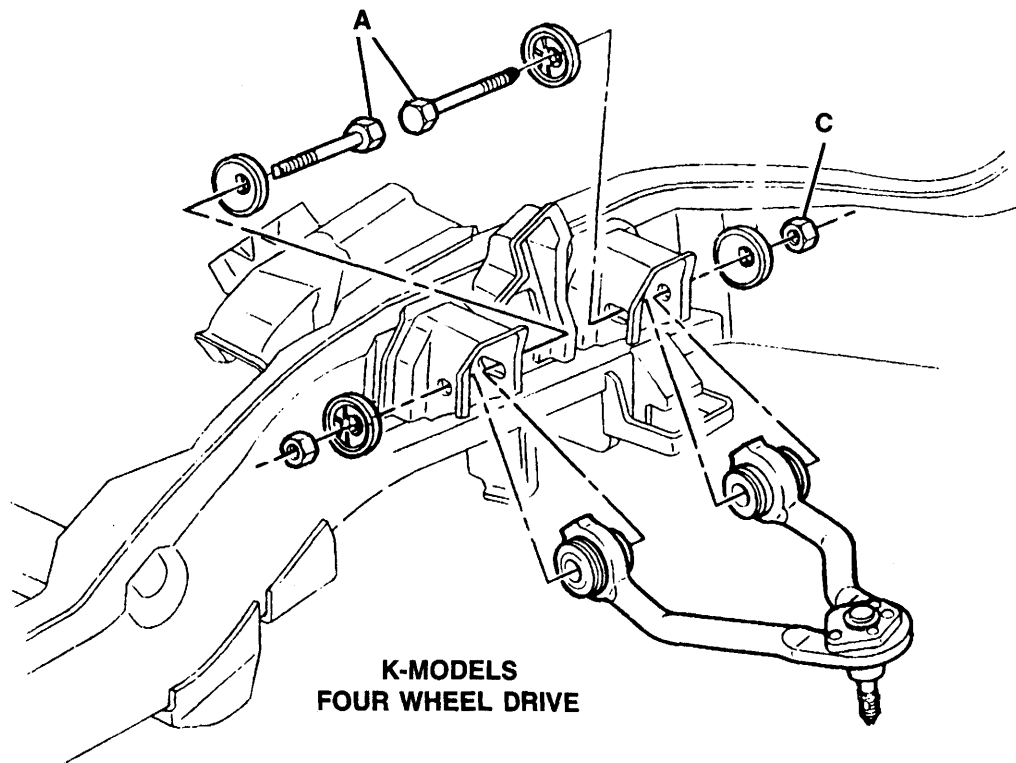
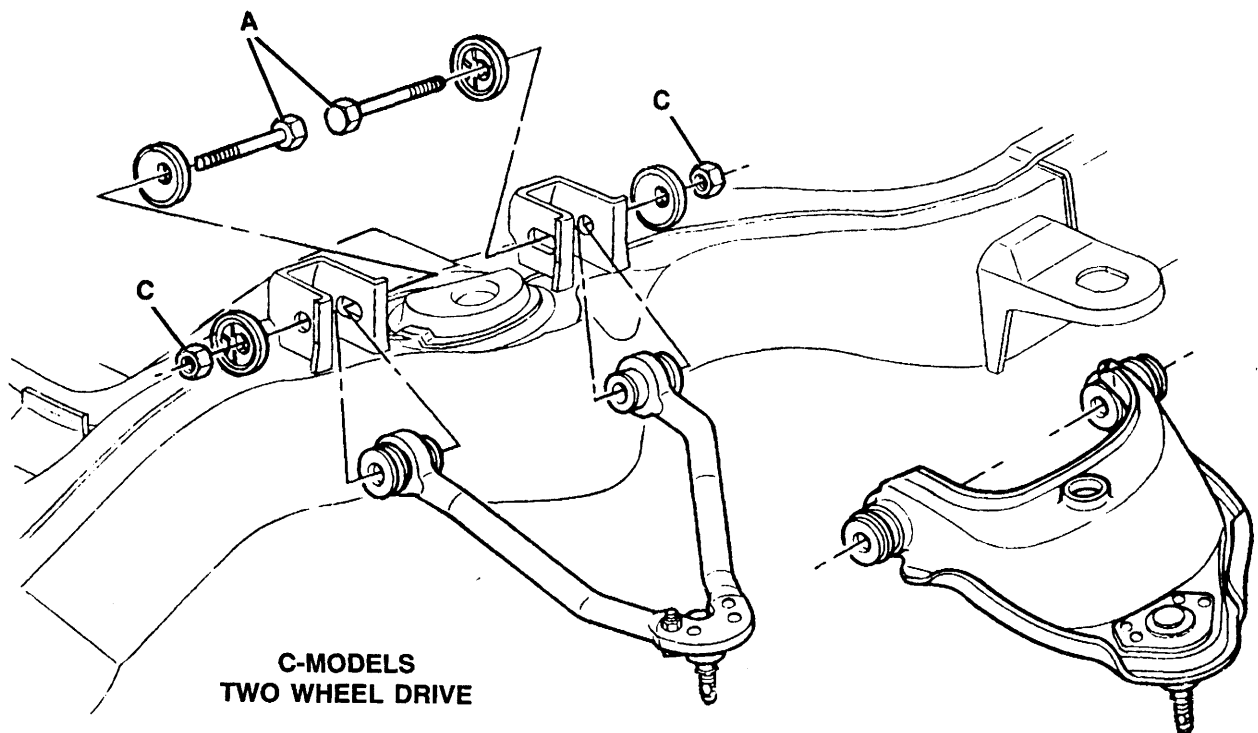
Tighten

- Tighten the front nut prior to tightening the rear nut.
- Nuts (145) to 190 N.m (140 lbs. ft.).
- The nuts (145) must be tightened with the control arm at "Z" Height. Refer to SECTION 3A.
- 5. Upper ball joint (115) stud to the knuckle (117).
- 6. Nut (129) to the upper ball joint (115) stud.



Tighten

- Nut (129) to 115 N.m (84 lbs. ft.).



- A. MANDATORY BOLT POSITION
- B. ASSEMBLE AND ALIGN PRIOR TO TIGHTENING
- C. TIGHTEN FRONT NUT PRIOR TO TIGHTENING
REAR NUT 190 N·m (140 FT. LBS.)

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Figure 41—Installing The Upper Control

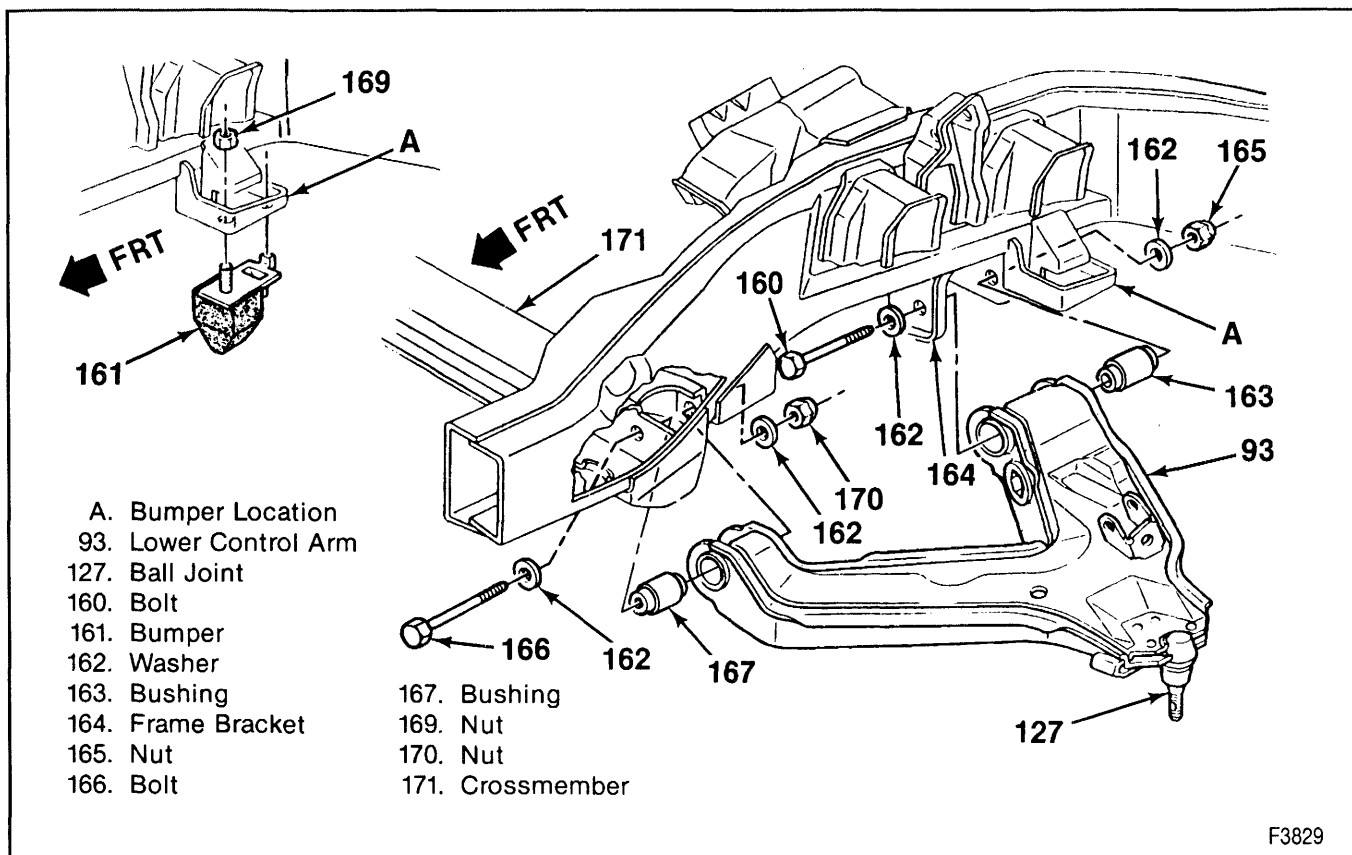


Figure 42—Lower Control Arm Components

- Tighten the nut to align the cotter pin. Do not tighten more than 1/6 turn.
- 7. New cotter pin.
 - Bend the cotter pin ends against the nut flats.
 - Remove the support from the knuckle.
- 8. Brake hose.
 - Bracket (142) and the hose.
 - Screw (143) and the nut.
- 9. Air cleaner extension, if needed.
- 10. Tire and wheel.
 - Lower the vehicle.

LOWER CONTROL ARM AND BUSHING REPLACEMENT

↔ Remove or Disconnect (Figures 29, 40, 42, and 43)

Tools Required:

J 24319-01 Steering Linkage Puller
 J 36202 Torsion Bar Unloading Tool
 J 36618 Series 30 Lower Control Arm Bushing Service Set
 J 9519-23 Ball Joint C-Clamp

- Raise the vehicle and support it with suitable safety stands.

1. Tire and wheel.
 - Unload the torsion bar, using J 36202. Mark the adjuster bolt for installation. Refer to "Torsion Bars and Support Assembly Replacement."
 - Slide the bar forward to remove the adjuster arm.

2. Adjuster arm (186).
3. Outer axle shaft nut (120) and washer (119) from the hub assembly (114).
 - Install a cover on the axle joint (132) (figure 36).
4. Brake caliper. Refer to SECTION 5B1.
5. Brake rotor. Refer to "Rotor Replacement."
6. Lower shock bolt from control arm and compress shock.
7. Inner tie rod end from the relay rod, using J 24319-01.
 - Support the lower control arm with a jack.
8. Stabilizer link from control arm. Refer to "Stabilizer Shaft Replacement."
9. Drive axle (121), using a puller, from the hub assembly (114).
10. Cotter pin (130) and nut (129) from the upper ball joint (115).
11. Upper ball joint (115) from knuckle (117) using J 36607.
12. Nuts (170 and 165) and washer (162).
13. Bolts (166 and 160).
14. Lower control arm (93) and knuckle (117) as a unit.
15. Front bushing (167)
 - Unbend crimps, using a punch.
 - Remove the bushing, using J 36618-2, J 9519-23, J 36618-4, and J 36618-1.
16. Rear bushing (163) (no crimp)
 - Remove using J 36618-5, J 36618-3, J 36618-2, and J 9519-23.
 - Replace lower the control arm on K 1, 2 vehicles if the bushings are worn or damaged.

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- E. Slide the torsion bars forward.
- F. Remove the adjustment arms (186).
- 2. Nuts (177, 179, and 189) and bolts (178, 180, and 181) from the torsion bar support crossmember (175).
 - Slide the support crossmember (175) rearward.
- 3. Torsion bars (182).
 - Note the location and the front ends of the torsion bars. There are different bars for the left and right sides.
- 4. Support crossmember (175).
- 5. Retainer (188), spacer (176), and insulator (187) from the support crossmember.

Install or Connect (Figures 43 and 44)

Tool Required:

J 36202 Torsion Bar Unloading Tool

- 1. Insulator (187), spacer (176), and retainer (188) on the support crossmember (175).
- 2. ~~Support crossmember assembly (175)~~ on the frame ~~around~~ of the mounting holes.
- 3. Torsion bars (182).
 - Make sure the bars (182) are on their respective sides.

- Slide the support crossmember (175) forward until the torsion bars (182) are supported.
- 4. Adjustment arms (186) on the torsion bars (182).

NOTICE: Refer to "Notice" on page 3C-1.

- 5. Bolts (178, 180, and 181) and nuts (177, 179, and 189) into the torsion bar support crossmember (175).

Tighten

- Center nut (189) to 24 N.m (18 ft.lbs.).
- Edge nuts (177 and 179) to 62 N.m (46 ft.lbs.).
- 6. Adjustment retainer plate (185) and bolt (184) on both torsion bars.
 - Increase the tension on the torsion bar, using J 36202.
 - Install the retaining plate and the adjustment bolt.
 - Set the adjustment bolt to the marked setting.
 - Release the tension on the torsion bar until the load is taken up by the adjustment bolt.
 - Remove J 36202.
- Lower the vehicle.
- Check the "Z" height. Refer to SECTION 3A.

ON-VEHICLE SERVICE: I-BEAM FRONT SUSPENSION (C3HD)

SHOCK ABSORBER

Remove or Disconnect (Figure 45 and 47)

- Raise the vehicle and support it with suitable safety stands.

- 1. Tire and wheel assembly.
- 2. Nut (195) and washer (196).
- 3. Shock absorber (197) from the leaf spring spacer (242).
- 4. Nut (195), washer (196) and bolt (253).
- 5. Shock absorber from the frame.

190. HANGER, SPRING
192. WASHER
193. BOLT
194. NUT
195. NUT
196. WASHER
197. ABSORBER, ASSEMBLY
198. WASHER
199. NUT
200. LINK, STABILIZER
201. RETAINER
202. INSULATOR
203. BOLT
204. WASHER
205. BRACKET, FRONT
STABILIZER
211. KNUCKLE, STEERING
213. NUT
219. NUT
220. NUT
221. HUB
223. PIN, COTTER
224. ROD, AXLE TIE
225. SHIELD, SPLASH
226. CALIPER, BRAKE
227. WASHER

228. BOLT
229. PLATE, ANCHOR
230. SHIELD, BEARING SEAL
232. CAP, RETAINER
233. PIN, COTTER
234. NUT
235. WASHER
236. BEARING, OUTER
237. BOLT, HUB
238. ROTOR, HUB
239. BEARING, INNER
240. SEAL, BEARING
241. AXLE, FRONT
242. SPACER, SPRING
243. BOLT
244. SPRING, FRONT
245. NUT
246. SPACER
247. U-BOLT
248. SHAFT, STABILIZER
249. INSULATOR
250. CLAMP
251. BOLT
252. CUSHION
253. BOLT

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Figure 45—C3HD Model I-Beam Front Axle Suspension Components - Legend

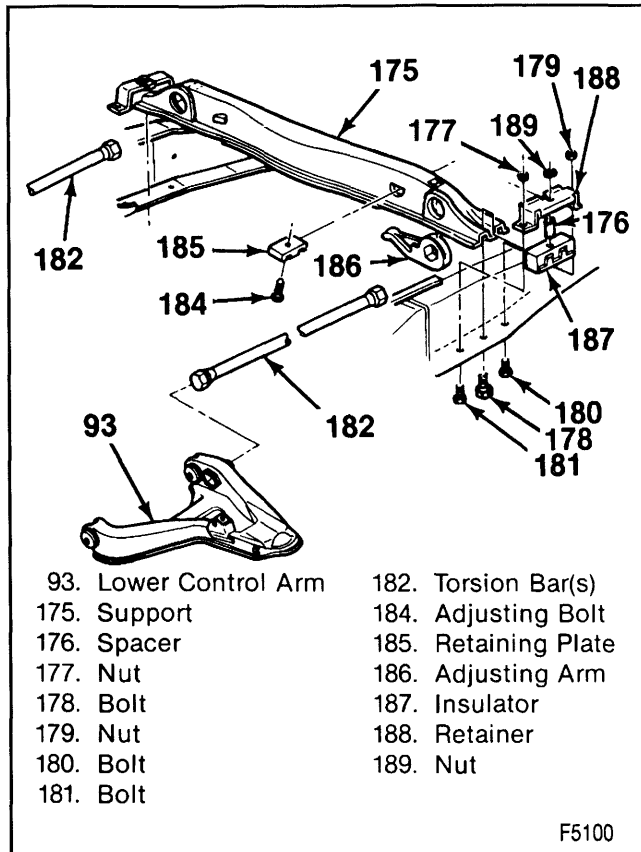


Figure 43—Torsion Bars and Support

→← Install or Connect (Figures 29, 40, 42 and 43)

NOTICE: For steps 5, 7, and 10, refer to "Notice" on page 3C-1.

Tools Required

J 36618-30 Series Lower Control Arm Bushing Service Set

J 36202 Torsion Bar Unloading Tool

J 9519-23 Ball Joint C-Clamp

1. Front bushing, using J 36618 and J 9519-23.
 - K 3 vehicle only.
 - After installing the bushing, crimp it in place.
2. Rear bushing, using J 36618 and J 9519-23.
3. Lower control arm (93) and knuckle assembly (117) to the crossmember (171) and the frame bracket (164).
 - Install the front leg of the lower control arm into the crossmember (171) before installing the rear leg into the frame bracket (164).
4. Bolts (166, 160) in the direction shown in (figure 42).
5. New nuts (170 and 165).

 **Tighten**

- Tighten front nut prior to tightening rear nut.
- Nuts (170 and 165) to 185 N.m (135 lbs. ft.).
- The nuts must be tightened with the control arm at the specified "Z" height. Refer to SECTION 3A.
- Prelube the steering knuckle seal.
- Start the drive axle through the hub.

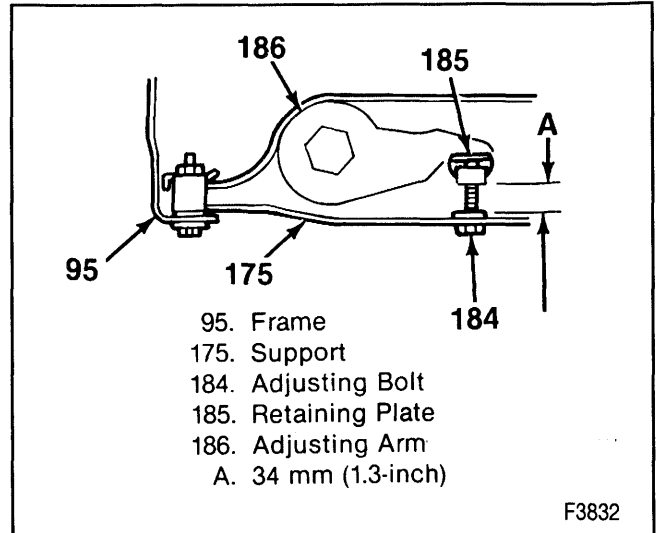


Figure 44—Torsion Bar Adjuster Height

6. Ball joint (115) to the knuckle (117).
7. Ball joint nut (131).

 **Tighten**

- Nut (131) to 130 N.m (96 lbs. ft.).
8. Cotter Pin (130).
 - Flatten the cotter pin against the sides of the nut.
 9. Adjuster arm (186).
 - Slide the bar rearward to install the sides of the nut.
 - Load the torsion bar, using J 36202.
 - Install the adjuster bolt and screw it down to the installation mark.
 10. Outer axle shaft washer (119) and nut (120) to the hub assembly (114).

 **Tighten**

- Nut (120) to 235 N.m (173 lbs. ft.).
11. Lower shock bolt. Refer to "Shock Absorber Replacement."
 12. Stabilizer link. Refer to "Stabilizer Shaft Replacement."
 13. Tire and wheel.

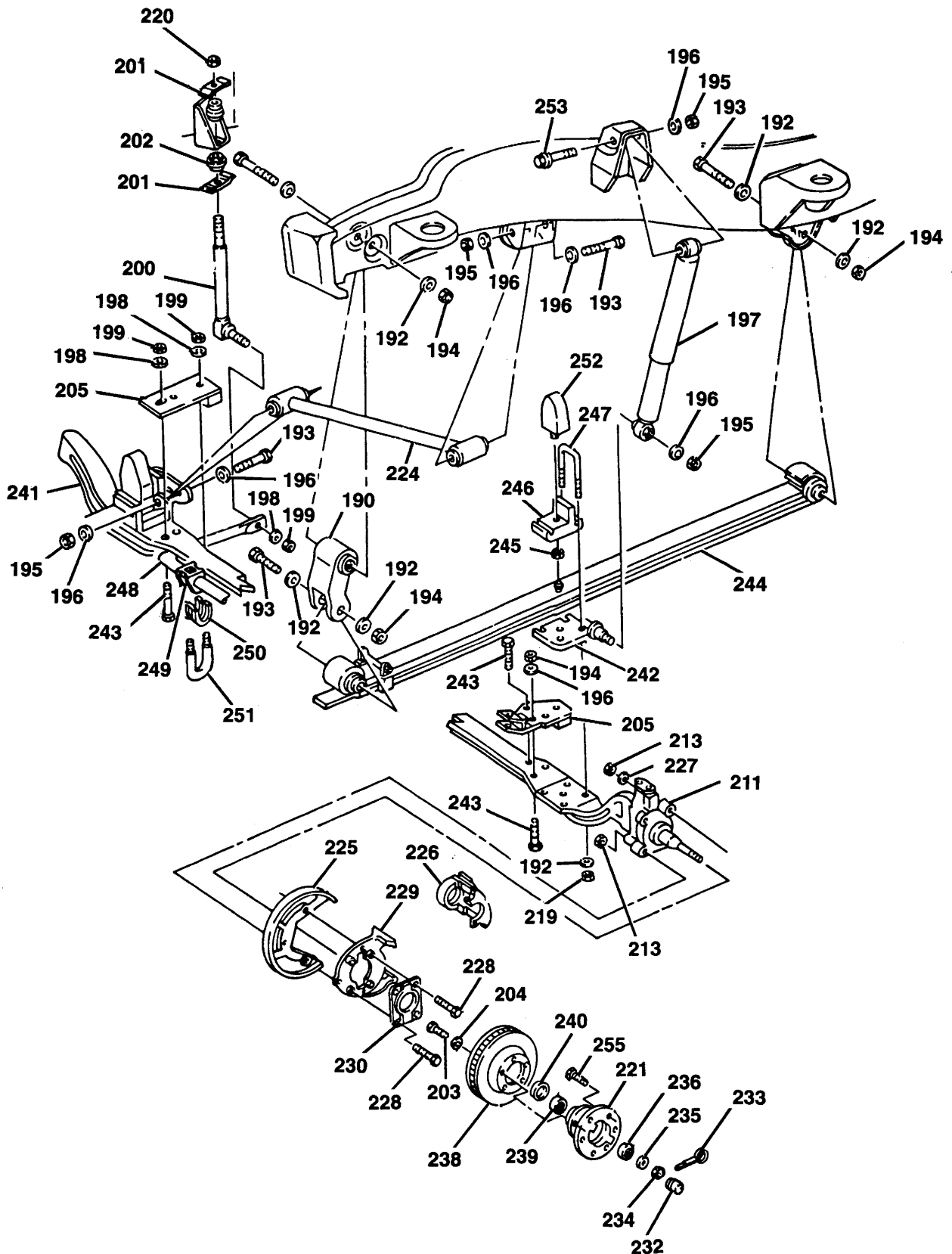
TORSION BAR(S) AND SUPPORT ASSEMBLY REPLACEMENT

→← Remove or Disconnect (Figures 43 and 44)

Tool Required:

J 36202 Torsion Bar Unloading Tool

- Raise the vehicle and support it with suitable safety stands.
1. Adjustment assemblies on both torsion bars.
 - A. Mark the adjustment bolt (184) setting.
 - B. Increase the tension on the adjustment arm (186) using J 36202.
 - C. Remove the adjustment bolt (184) and retaining plate (185).
 - D. Move the tool aside.



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Figure 46—C3HD Model I-Beam Front Axle Suspension Components

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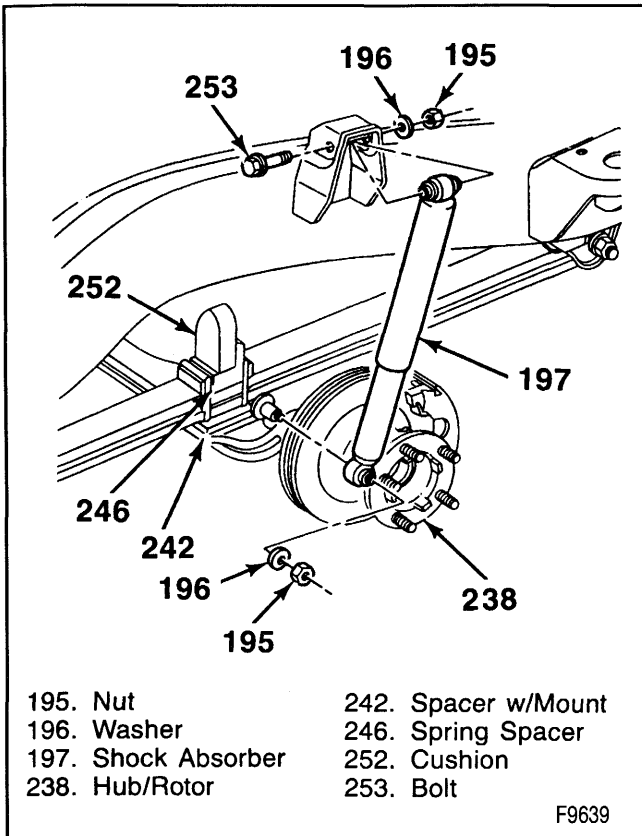


Figure 47—Shock Absorber Attachment Points

Inspect

- Shock absorbers for damage and leakage.
- Test the shock absorbers. Refer to "Shock Absorber Bench Test."

Install or Connect (Figures 45, 46, and 47)

- Shock absorber (197) to the frame (figure 47).
 - Insert bolt (253) through the upper shock bracket and shock absorber.
- Washer (196) and nut (195).
 - Do not tighten.
- Shock absorber to the leaf spring spacer (242) (figure 47).
 - Position the lower shock mount onto the stud.

NOTICE: Refer to "Notice" on page 3C-1.

- Washer (196) and nut (195).

Tighten

- Shock absorber upper nut to 185 N.m (136 lbs. ft.).
 - Shock absorber lower nut to 50 N.m (37 lbs. ft.).
- Tire and wheel assembly.
 - Lower the vehicle.

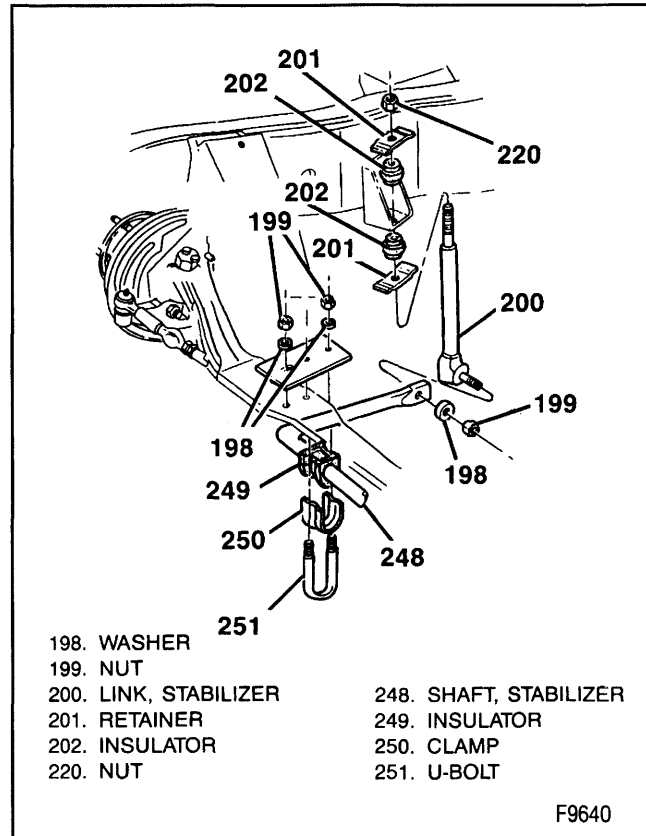


Figure 48—Stabilizer Shaft Components

STABILIZER SHAFT

Remove or Disconnect (Figures 45, 46, and 48)

Tool Required:

J 6627-A Tie Rod Remover

- Raise the vehicle and support it with suitable safety stands.
- Tire and wheel assembly.
 - Nut (199) and washer (198).
 - Stabilizer shaft (248) from the stabilizer link (200).
 - Use J 6627-A to separate the stabilizer link from the stabilizer end.
 - Nuts (199), washers (198), clamp bolts (251), and clamps (250).
 - Stabilizer shaft (248) from the axle.
 - Insulator (249) from the stabilizer shaft (248).
 - Nut (220), retainer (201) insulator (202).
 - Stabilizer link (200) from the frame bracket.
 - Pull the link from the bracket. Another insulator (202) and retainer (201) will come off the link.

Install or Connect (Figures 45, 46, and 48)

NOTICE: For steps 2, 5 and 7, refer to "Notice" on page 3C-1.

- Stabilizer link (200) to the frame bracket.
 - Slide a retainer (201) and an insulator (202) on to the link and insert the link into the proper hole in the frame bracket.

2. Insulator (202), retainer (201) and nut (220).



Tighten

- Nut (220) until the distance between each retainer is 38 mm (1.5 inches).
3. Stabilizer shaft to the front axle (241).
 4. Insulators (249) onto the stabilizer shaft.
 5. Clamps (250), clamp bolts (251), washers (198) and nuts (199).



Tighten

- Nuts (199) to 28 N.m (21 lbs. ft.).
6. Stabilizer shaft to the stabilizer link.
 7. Washer (198) and nut (199).



Tighten

- Nuts (199) to 68 N.m (50 lbs. ft.).
8. Tire and wheel assembly.
 - Lower the vehicle.

WHEEL HUB/ROTOR ASSEMBLY



Remove or Disconnect (Figures 45 and 46)

- Raise the vehicle and support it with suitable safety stands.
1. Tire and wheel assembly.

NOTICE: Support the caliper with a piece of wire to prevent damage to the brake line.

2. Brake caliper. Refer to SECTION 5B1.
3. Retainer/cap (232).
4. Cotter pin (233), nut (234) and washer (235).
5. Wheel hub/rotor (238).
 - Pull the hub/rotor free from the spindle, making sure the outer wheel bearing (236) comes free.
 - Do not damage the steering knuckle spindle threads.
6. Inner wheel bearing (239).
 - Pry out the seal (240).
7. Races.
 - Drive out each race using a brass drift.

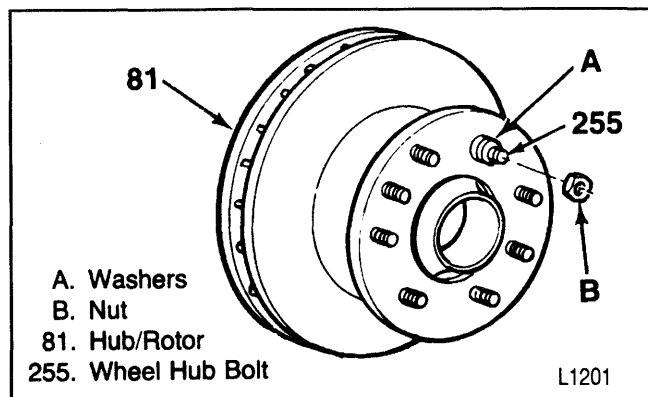


Figure 49—Installing the Hub Bolts



Clean

1. Grease from the hub/rotor (238) and steering knuckle spindle.
 - Grease from inside the hub.
2. Grease from the wheel bearings (236 and 239) and races.
 - Use clean solvent and a small brush with no loose bristles.

NOTICE: Do not spin the wheel bearings with compressed air to dry them—the wheel bearings may be damaged.



Inspect

1. Wheel bearings (236 and 239) and their races for damage or wear.
 - Refer to "Diagnosis of Wheel Bearings."
 - If either a bearing or its race is damaged or worn, replace both.
2. Hub/rotor (238) for damage or wear.
 - Check for out-of-round or scored conditions.
 - Check for pitting or cracks.
 - Repair or replace as necessary.



Install or Connect (Figures 45 and 46)

Tools Required:
J 9746-02 Hub/Rotor Support

NOTICE: Start the races squarely inside the hub/rotor to avoid distortion and possible cracking.

1. Races into the hub/rotor.
 - A. Place the hub/rotor on J 9746-02 and rest this assembly on press bars.
 - B. Use a 7.6-cm (3-inch) diameter bar or equivalent to press the outer bearing race into position.
 - C. Remove J 9746-02 and use a 7.6-cm (3-inch) diameter bar (or equivalent tool) to press the inner bearing race into position. If the bar is larger than 7.6 cm (3 inches), it may damage the bearing seal seat.



Important

- Use an approved high-temperature front wheel bearing grease to lubricate the bearings. Refer to SECTION 0B.
 - Do not mix different greases as mixing may change the grease's properties resulting in poor performance.
2. Apply a thin film of grease to the steering knuckle spindle at the outer wheel bearing seat and at the inner wheel bearing seat, shoulder, and seal seat.
 3. Put a small quantity of grease inboard of each wheel bearing retainer/cap (232).
 4. Fill each wheel bearing (cone and roller assembly) full of grease.
 - Use a cone-type grease machine that forces grease into the bearing.

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- If a cone-type grease machine is not available, pack the wheel bearing by hand.
- When packing the wheel bearing by hand, work the grease into the bearings between the rollers, cones, and the cage.

NOTICE: Failure to completely pack the wheel bearing (cones, rollers, and cage) with grease will result in premature wheel bearing damage and/or wear.

5. Inner wheel bearing (239) into the hub/rotor (238).
 - Put an additional quantity of grease outboard of this bearing.
6. New seal (240).
 - Use a seal installer or block to install the seal to ensure it is flush with the hub/rotor flange.
 - Lubricate the seal lip with a thin layer of grease.
7. Hub/rotor (238).
 - Do not damage the steering knuckle spindle threads.
8. Outer wheel bearing (236).
 - Slide it over the spindle until the wheel bearing (236) fully seats against the hub/rotor outer race.

NOTICE: Refer to "Notice" on page 3C-1.

9. Washer (235), nut (234) and cotter pin (233).
 - Do not place the cotter pin through the hole in the spindle until the wheel bearings are adjusted.



Tighten

- Nut (234) to 16 N.m (12 lbs. ft.) while turning the hub/rotor assembly in either direction.
 - Put an additional amount of grease outboard of the wheel bearing (236).
 - Adjust the wheel bearings.
 - Refer to "Wheel Bearing Adjustment."
10. Cotter pin (233).
 11. Retainer/cap (232) in place.
 12. Brake caliper. Refer to SECTION 5B1.
 13. Tire and wheel assembly.
 - Lower the vehicle.

WHEEL BEARING ADJUSTMENT



Important

- The continuous smooth functioning of the front suspension cannot be maintained unless the front wheel bearings are correctly adjusted.
- The bearings must be a slip fit on the spindle and the wheel bearing must be lubricated to ensure that the roller bearings will roll and not skid.

- The spindle nut must have a free-running fit on the spindle threads.

NOTICE: Never preload the front wheel bearings. Damage can result by the steady thrust on the roller ends which comes from preloading.



Adjust

- Raise the vehicle and support it with suitable safety stands under the lower control arms.
1. Remove the retainer/cap (232).
 2. Remove the cotter pin (233).



Tighten

- Nut (234) to 16 N.m (12 lbs. ft.) while rotating the wheel and tire assembly (or the hub/rotor). This will seat the bearings.
3. Back off the nut (234) one flat.
 - If the hole in the spindle lines up with the slot in the nut, insert the cotter pin (233).
 - If they do not line up, back off the nut until they do, but not more than one additional flat.



Measure

- Endplay in the hub/rotor should measure between 0.013-0.20 mm (0.005-0.008 inches) when properly adjusted.
4. Install the retainer/cap (232).
 - Lower the vehicle.

WHEEL HUB BOLT REPLACEMENT



Remove or Disconnect (Figure 49)

Tools Required:

J 9746-02 Hub/Rotor Support

1. Hub/rotor assembly from the vehicle.
 - Refer to "Wheel Hub/Rotor Assembly."

NOTICE: Place J 9746-02 between the press bars and the hub/rotor to protect the rotor surfaces.

2. Wheel hub bolts (237) with a press (figure 49).
 - Support the hub/rotor (238) using J 9746-02 and the press bars.
 - Do not damage the wheel mounting surface on the hub/rotor flange.



Install or Connect (Figure 49)

NOTICE: Refer to "Notice" on page 3C-1.

1. Wheel hub bolts (237) into the hub/rotor (238).
 - Place four washers onto the bolt, then fasten a nut onto the bolt until the nut bottoms on the washers (figure 49).

- Tighten the nut until the bolt fully seats into the hub/rotor (238).
 - Remove the nut and washers.
2. Hub/rotor to the vehicle.
 - Refer to "Wheel Hub/Rotor Assembly."
 3. Tire and wheel assembly.
 - Lower the vehicle.

STEERING ARM, KNUCKLE, AND SPINDLE

Remove or Disconnect (Figures 45 and 46)

- Raise the vehicle and support it with suitable safety stands.
1. Tire and wheel assembly.
 2. Brake caliper. Refer to SECTION 5B1.
 3. Hub/rotor assembly (238).
 - Refer to "Wheel Hub/Rotor Assembly."
 4. Bolts (228), washers (227), and nuts (213).
 5. Anchor plate (229), splash shield (225), and the steering arm (224).
 - Pull the anchor plate and splash shield off the knuckle. Steering arm hangs by the rods.
 - Bolts (228) and washers (227) to separate the anchor plate from the splash shield.
 - Refer to SECTION 3B3 to separate the steering arm from the tie rod and pitman arm.
 6. Bolts (203) and washers (204).
 7. Brake hose bracket (205).
 8. Gaskets (207).
 9. Caps (206) from the steering knuckle (211).
 10. Nut (216) and washer (217).
 11. Lock pin (218)
 12. King pin (208) from the steering knuckle (211).
 - Drive the king pin out using a drift.
 - Spacers (210) and bushings (209) will also come out.
 13. Steering knuckle (211) from the axle (241).
 14. Dust seal (214), shim (215) and thrust bearing (221).

Install or Connect (Figures 45 and 46)

NOTICE: For steps 5, 8, and 11, refer to "Notice" on page 3C-1.

1. Bushings (209).
 - Ream new bushings to 29.982-30.022 mm (1.1804-1.1820 in.) after installing.
2. Steering knuckle (211).
3. Thrust bearing (221), shim (215) and dust seal (214).
 - Prelube the thrust bearing. Refer to SECTION 0B.
4. King pin (208) and the lock pin (218).
 - Prelube the king pin.
 - Insert the spacers in the correct order.
5. Washer (217) and nut (216).

Tighten

- Nut (216) to 40 N.m (29 lbs. ft.).

6. Gaskets (207).
7. Caps (206) to the steering knuckle (211).
8. Brake hose bracket (205).

Tighten

- Bolts (119) to 7 N.m (60 lbs. ft.).
9. Steering arm (224), splash shield (225) and anchor plate (229).
 10. Bolts and washers to attach splash shield to anchor plate.
 11. Bolts (228), washers (227) and nuts (213) to attach anchor plate and steering arm to the steering knuckle.

Tighten

- Bolts (228) to 16 N.m (12 lbs. ft.).
 - Nuts (213) to 312 N.m (230 lbs. ft.).
12. Steering arm (224) to the steering linkage.
 - Refer to SECTION 3B3.
 13. Hub/rotor assembly (238).
 - Refer to "Wheel Hub/Rotor Assembly."

Adjust

- Adjust the wheel bearings. Refer to "Wheel Bearing Adjustment."
14. Brake caliper. Refer to SECTION 5B1.
 15. Tire and wheel assembly.
 - Lower the vehicle.
 - Check the front end alignment and reset as required.
 - Refer to SECTION 3A.

FRONT AXLE

Remove or Disconnect (Figures 45 through 48 and 50)

Tool Required:

J 6627-A Tie Rod Remover

- Raise the vehicle and support it with suitable safety stands on the frame.
1. Tire and wheel assembly.
 - Support the axle with a floor jack to eliminate any load on the springs.
 2. Steering arm, knuckle, and spindle.
 - Refer to "Steering Arm, Knuckle, and Spindle."
 3. Nut (195) and washer (196).
 4. Shock absorber (197) from the axle (241) (figure 48).
 5. Nut (199) and washer (198).
 6. Stabilizer link (200) from the stabilizer shaft (248) (figure 48).
 - Use J 6627-A to separate the stabilizer shaft from the stabilizer link.
 7. Nut (220), retainer (201) and insulator (202).
 8. Stabilizer link (200) from the axle (241) (figure 45).
 - Pull the link free from the axle, making sure not to lose the other insulator and retainer.
 9. Nuts (219), washers (192), and U-bolts (247).
 10. Spacer (246) and spring spacer (242).
 11. Leaf spring (244) from the axle (figure 50).

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12. Steering damper from the axle. Refer to SECTION 3B3.

- Lower the floor jack and pull the axle clear of the vehicle.

 **Install or Connect (Figures 45 through 48, and 50)**

NOTICE: For steps 5, 7, and 9, refer to "Notice" on page 3C-1.

- Line up the axle under the leaf springs.
- Raise it into position using a floor jack.

1. Steering damper to the axle.
 - Refer to SECTION 3B3.
2. Axle (241) to the leaf springs (244).
 - Refer to "Leaf Spring."
3. Stabilizer link (200) to the axle (figure 48).
4. Link into the hole on the spring spacer (242) and axle.
5. Insulator (202), retainer (201), and nut (220).

 **Tighten**

- Nut (220) until the distance between each retainer (117) is 38.0 mm (1.5 inches) (figure 51).

6. Stabilizer link to the stabilizer shaft (figure 48).

7. Washer (198) and nut (199).

 **Tighten**

- Nut (199) to 68 N.m (50 lbs. ft.).

8. Shock absorber to the axle .

9. Washer (196) and nut (195).

 **Tighten**

- Nut (195) to 50 N.m (37 lbs. ft.).

10. Steering arm, knuckle, and spindle.

- Refer to "Steering Arm, Knuckle, and Spindle."

 **Adjust**

- Adjust the wheel bearings. Refer to "Wheel Bearing Adjustment."

11. Tire and wheel assembly.

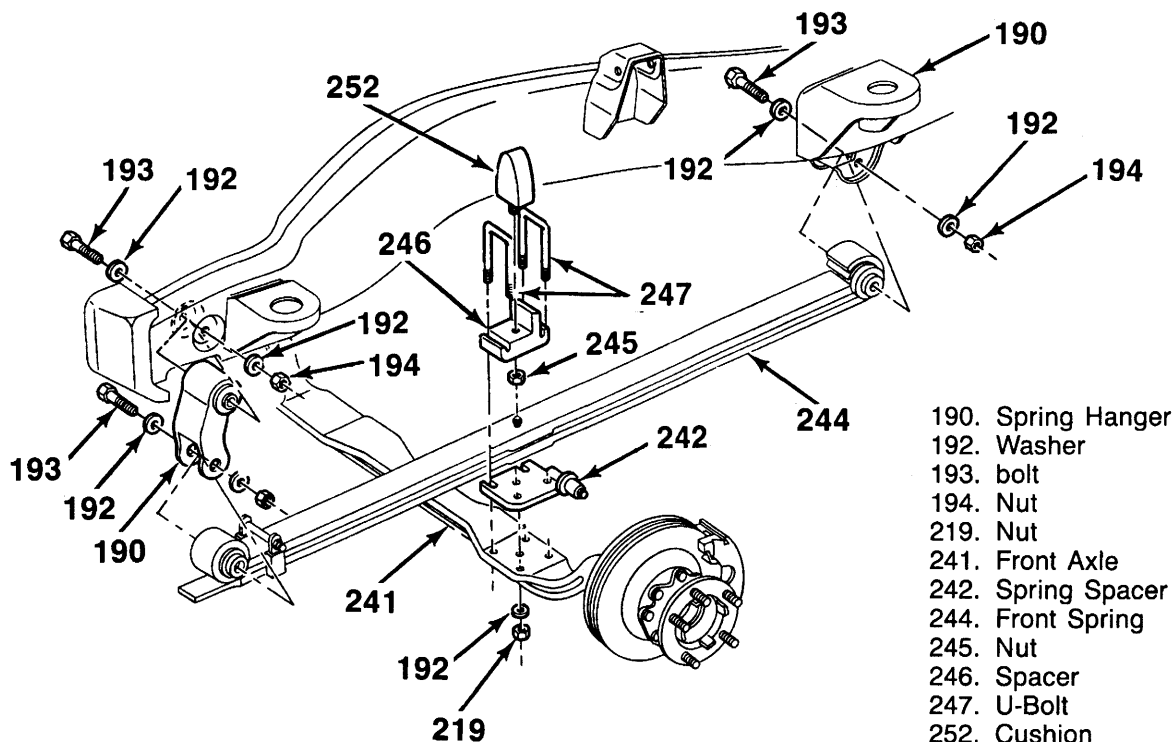
- Lower the vehicle.
- Check the front end alignment and reset as required.
- Refer to SECTION 3A.

LEAF SPRINGS

 **Remove or Disconnect (Figures 45 through 48 and 50)**

Tool Required:

J 6627-A Tie Rod Remover



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Figure 50—Axle and Leaf Spring Attachment Points

- Raise the vehicle and support it with suitable safety stands. Support the axle separately to eliminate any load on the springs.
- 1. Tire and wheel assembly.
- 2. Nut (195) and washer (196).
- 3. Shock absorber (197) from the axle (241) (figure 47).
- 4. Nut (199) and washer (198).
- 5. Stabilizer link (200) from the stabilizer shaft (248) (figure 48).
 - Use J 6627-A to separate the stabilizer shaft from the stabilizer link.
- 6. Nut (220), retainer (201) and insulator (202).
- 7. Stabilizer link (200) from the axle.
 - Pull the link free from the axle, making sure not to lose the other insulator and retainer.
- 8. Nuts (219), washers (192) and U-bolts (247).
- 9. Spacer (246) and spring spacer (242).
- 10. Leaf spring (244) from the axle.
- 11. Nut (194), washer (192), bolt (193), and washer (192) to separate the spring from the rear shackle (190).
- 12. Nut (194), washer (192), bolt (193), and washer (192) to separate the spring from the front hanger (190).
 - Pull the leaf spring back and out.
- 13. Leaf spring (244) from the frame.

Install or Connect (Figures 45 through 48, and 50)

NOTICE: For steps 3, 5, 7, 9, and 11, refer to "Notice" on page 3C-1.

1. Leaf spring (244) to the frame.
 - Line up the spring with the spring hanger (190) and the spring hanger (190). Double wrap end is toward the front of the vehicle.
2. Washer (192), bolt (193), washer (192) and nut (194) to attach the spring to the front spring hanger (190).
3. Washer (192), bolt (193), washer (192), and nut (194) to attach the spring to the spring hanger (190).

Tighten

- Nut (194) to 125 N.m (92 lbs. ft.).
- 4. Leaf spring (244) to the axle.
 - Position the spring spacer (242) onto the axle. Either aligning pin can contact the edge of the leaf spring after the assembly is complete.
- 5. Spacer (246), U-bolts (247), washers (192), and nuts (219).

Tighten

- Nuts (219) to 25 N.m (18 lbs. ft.) in a diagonal sequence (e.g., 1-3-4-2).
- Nuts (219) in a diagonal sequence (e.g., 1-3-4-2) to 109 N.m (80 lbs. ft.).

6. Stabilizer link (200) to the axle.
 - Insert the link into the proper hole in the axle after the retainer (201) and insulator (202) are attached.
7. Insulator (202), retainer (201), and nut (220).

Tighten

- Nut (220) until the distance between each retainer (201) is 38.0 mm (1.5 inches) (figure 51).
- 8. Stabilizer link (200) to the stabilizer shaft (248) (figure 45).
- 9. Washer (198) and nut (199).

Tighten

- Nut (199) to 68 N.m (50 lbs. ft.).
- 10. Shock absorber (197) to the axle.
- 11. Washer (196) and nut (195).

Tighten

- Nut (195) to 50 N.m (37 lbs. ft.).
- 12. Tire and wheel assembly.
 - Lower the vehicle.
 - Check the front end alignment and reset as required. Refer to SECTION 3A.

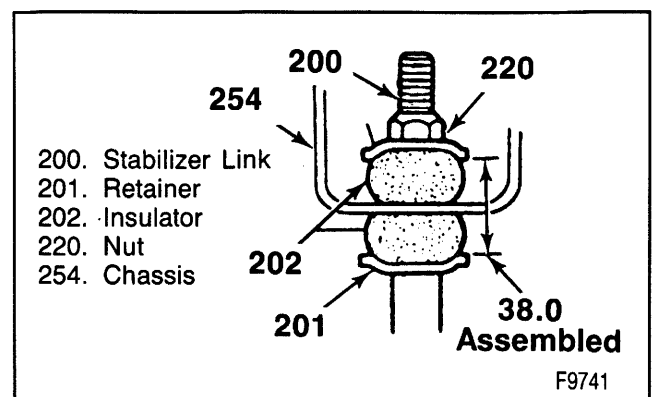


Figure 51—Stabilizer Link Hardware Tightened Dimension

SPECIFICATIONS**FASTENER TIGHTENING SPECIFICATIONS**

TWO-WHEEL DRIVE	N·m	Lbs. Ft.	Lbs. In.
BALL JOINTS			
Lower Ball Joint to Steering Knuckle Nut.....	128	94	—
Upper Ball Joint to Steering Knuckle Nut.....	100	74	—
BUMPER			
Lower Control Arm.....	32	23	—
CONTROL ARMS			
Lower Control Arm to Frame Attaching Nut (Rear)**	165	121	—
Upper Control Arm to Frame Attaching Nuts	190	140	—
SHOCK ABSORBER			
Shock Absorber to Control Arm Bolts.....	27	20	—
Shock Absorber Upper Attaching Nut.....	11	—	100
STABILIZER			
Stabilizer Bar Bracket to Frame Bolts and Nuts**	33	24	—
Stabilizer Link Nut*	18	13	—
STEERING KNUCKLE			
Splash Shield to Steering Knuckle Bolts	26	19	—
Wheel Bearing to Spindle Nut***	16	12	—

**Torque with the weight of the vehicle on the wheels.

***Refer to "Wheel Bearing Adjustment."

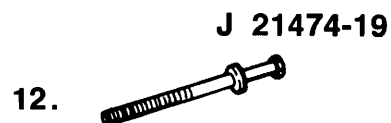
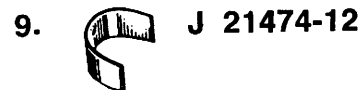
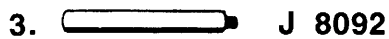
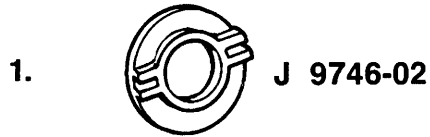
FOUR-WHEEL DRIVE	N·m	Lbs. Ft.	Lbs. In.
BALL JOINTS			
Lower Ball Joint to Steering Knuckle Nut.....	128	94	—
Upper Ball Joint to Steering Knuckle Nut.....	100	74	—
CONTROL ARMS			
Lower Control Arm to Frame Attaching Nuts	165	121	—
Upper Control Arm to Frame Attaching Nuts	190	140	—
FRONT DRIVE AXLE			
Drive Axle Nut to Hub and Bearing.....	235	173	—
Hub and Bearing Assembly, Shield and Knuckle.....	180	133	—
Retainer to Torsion Bar Support Bolts	48	35	—
Tie Rod Nut to Steering Knuckle	48	35	—
Torsion Bar Retainer Bolt/Screw	45	33	—
SHOCK ABSORBER			
Shock Absorber Upper Nuts.....	90	66	—
STABILIZER			
Stabilizer Shaft Clamp to Frame Bolts	33	24	—
Stabilizer Shaft Link Bolt	23	16	—

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FRONT SUSPENSION AND AXLE 3C-39

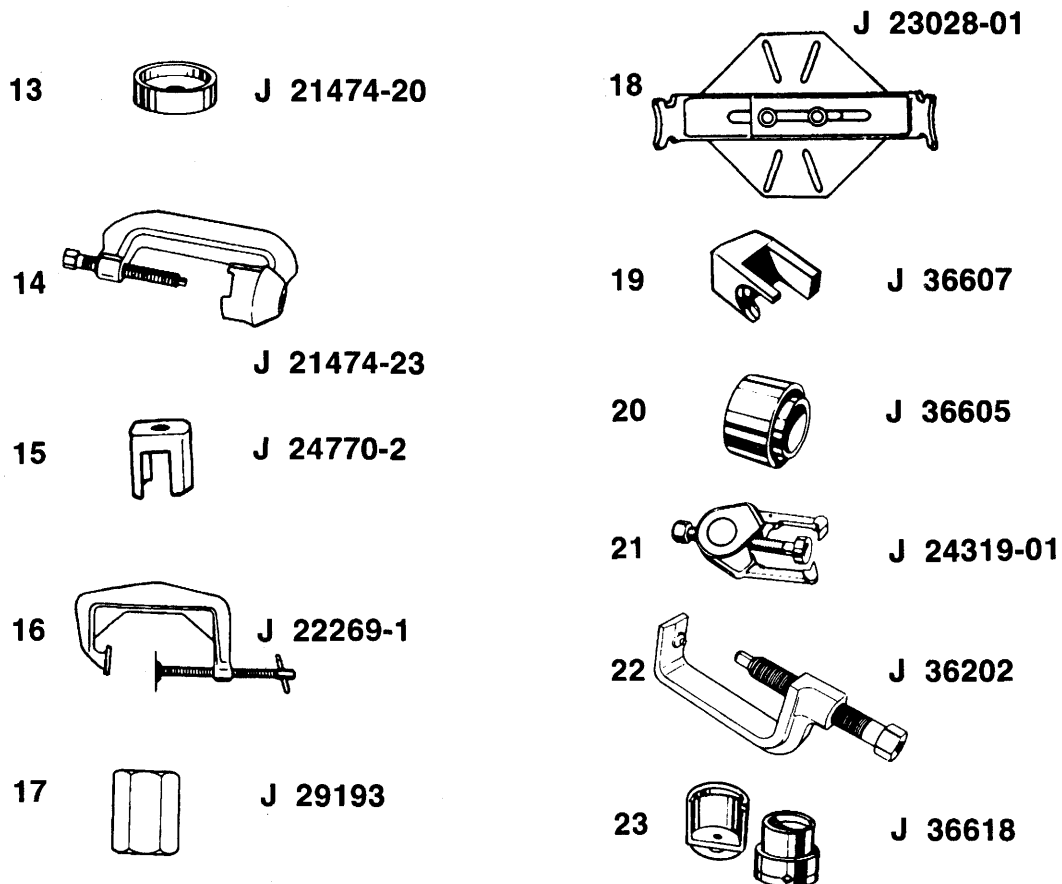
C3HD I-BEAM FRONT AXLE	N·m	Ft. Lbs.	Lbs. In.
ANCHOR PLATE			
Splash Shield to Anchor Plate	16	12	—
SHOCK ABSORBER			
Shock Absorber to Axle.....	85	62	—
Shock Absorber to Frame	85	62	—
SPRINGS			
Shackle to Frame Nuts.....	110	81	—
Spring to Axle U-Bolts	125	92	—
Spring to Hanger Nuts.....	110	81	—
Spring to Shackle Nuts.....	110	81	—
Suspension Bumper.....	34	25	—
STABILIZER			
Stablizer Clamp Bolts	29	21	—
Stabilizer to Stabilizer Link	29	21	—
Stabilizer Link to Frame.....	63	47	—
STEERING KNUCKLE			
Caps to Steering Knuckle.....	7	—	60
Lock Pin to Steering Knuckle.....	40	29	—
Steering Arm to Knuckle.....	312	230	—
			T2562

SPECIAL TOOLS



1. Bearing Remover
2. Front Outer Race Remover
3. Driver Handle
4. Wheel Stud and Tie Rod Remover
5. Ball Joint Separator
6. Ball Joint Remover and Installer Set
7. Receiver Tool
8. Lower Control Arm Bushing Remover
9. Lower Control Arm Bushing Installer Spacer
10. Lower Control Arm Bushing Installer
11. Special Nut
12. Special Bolt

SPECIAL TOOLS



- 13. Lower Control Arm Bushing Installer
- 14. Lower Control Arm Bushing Remover
- 15. Upper Control Arm Bushing Remover
- 16. Upper Control Arm Bushing Fixture
- 17. Steering Linkage Installer
- 18. Spring Remover
- 19. Ball Joint Separator
- 20. Steering Knuckle Seal Installer
- 21. Steering Linkage Puller
- 22. Torsion Bar Unloading Tool
- 23. Lower Control Arm Bushing Service Set

NOTES

SECTION 3D

REAR SUSPENSION

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

All C/K series vehicles use a leaf spring and solid rear axle suspension system. The rear axle assembly is attached to multi-leaf springs by U-bolts. The front ends of the springs are attached to the frame at the front hangers through rubber bushings. The rear ends of the springs are attached to the frame with shackles that

allow the springs to change their length while the vehicle is in motion.

Ride control is provided by two identical direct double-acting shock absorbers angle-mounted between the frame and brackets attached to the axle tubes.

ON-VEHICLE SERVICE

SHOCK ABSORBER REPLACEMENT

NOTICE: Original equipment shock absorbers serve additionally as suspension drop cut-offs. Replacement shock absorbers must have a built in suspension cutoff feature and must not be longer than original shocks when they are fully extended or serious vehicle or component damage could result.

Remove or Disconnect (Figure 1)

- Raise the vehicle on a hoist.
- 1. Upper shock nut (1) and bolt (2) from the frame bracket.
- 2. Lower shock nut (3), washer (4), and bolt (5) from the axle bracket.

3. Shock absorber (6) from the vehicle.

Install or Connect (Figure 1)

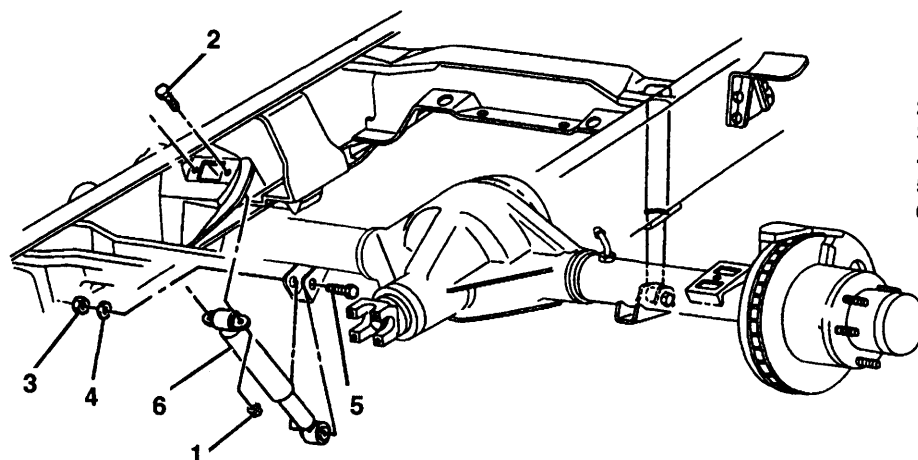
NOTICE: For steps 2, and 3, refer to "Notice" on page 3D-1.

1. Shock absorber (6) to the vehicle.
2. Lower shock bolt (5), washer (4), and nut (3).
3. Upper shock bolt (2) and nut (1).

Tighten

- The lower nut to 110 N.m (81 lbs. ft.).
- Upper nuts to 27 N.m (20 lbs. ft.).
- C3HD upper nuts to 23 N.m (17 lbs. ft.).

3D-2 REAR SUSPENSION

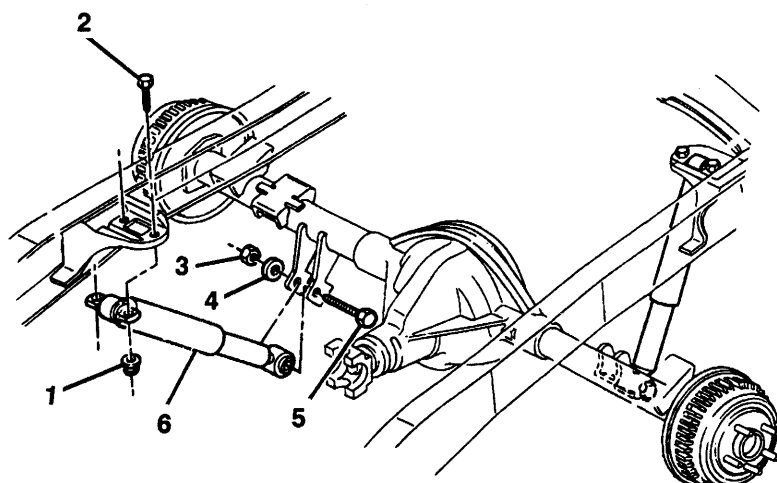
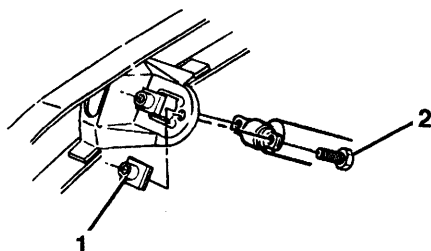
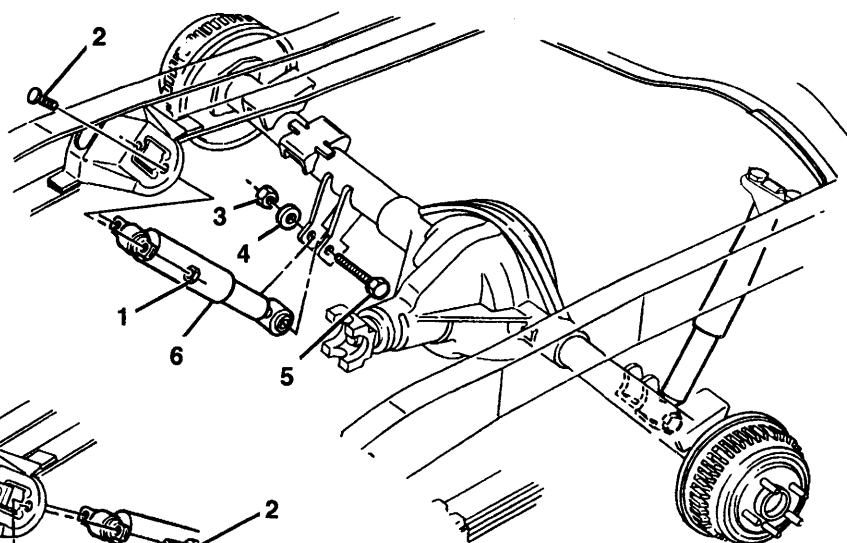


C3HD-MODELS

1. NUT 23 N-m (17 FT. LBS.)
2. BOLT
3. NUT 110 N-m (81 FT. LBS.)
4. WASHER
5. BOLT
6. ABSORBER, SHOCK

K-MODELS

1. NUT 27 N-m (20 FT. LBS.)
2. BOLT
3. NUT 110 N-m (81 FT. LBS.)
4. WASHER
5. BOLT
6. ABSORBER, SHOCK



C1, 2-MODELS

1. NUT 27 N-m (20 FT. LBS.)
2. BOLT
3. NUT 110 N-m (81 FT. LBS.)
4. WASHER
5. BOLT
6. ABSORBER, SHOCK

V3406

Figure 1—Shock Absorber Components

STABILIZER SHAFT REPLACEMENT

Remove or Disconnect (Figure 2)

- Raise the vehicle on a hoist.
- 1. Lower nuts (32), washers (36) and bolts (33) from stabilizer links (28).
- 2. Bolt/screws (37) from clamp (29).
- 3. Clamps (29) and insulators (31).
- 4. Stabilizer shaft (27).

Install or Connect (Figure 2)

NOTICE: For steps 3 and 5, refer to "Notice" on page 3D-1.

1. Stabilizer shaft (27) to rear axle.
2. Insulators (31) and clamps (29).
3. Bolt/screws (37) to clamp.
4. Lower bolts (33) through washers (36), stabilizer link (28), and washers (36).
5. Nuts (32).

Tighten

- Bolts/screws (37) to 34 N.m (25 lbs. ft.).
- Nuts (32) to 45 N.m (33 lbs. ft.).

C/K 3 MODELS

Remove or Disconnect (Figure 2)

- Raise the vehicle on a hoist.
- 1. Nuts (42) and insulators (41).
- 2. Bolts (38) from spacer (39) and stabilizer shaft (27).
- 3. Nuts (35) from U-bolts.
- 4. U-Bolts (40), clamps (29) and insulators (31).
- 5. Stabilizer shaft (27).

Install or Connect (Figure 2)

NOTICE: For steps 3 and 5, refer to "Notice" on page 3D-1.

1. Stabilizer shaft (27) to rear axle.
2. Insulators (31), clamps (29) and U-bolts (40).
3. Nuts (35) to U-bolt (40).
4. Bolts (38) through insulators (41), stabilizer shaft (27) and spacers (39).
5. Nuts (42).

Tighten

- Nuts (35) to 30 N.m (22 lbs. ft.).
- Nuts (42) to 23 N.m (17 lbs. ft.).

LEAF SPRING REPLACEMENT

Remove or Disconnect (Figures 3 and 4)

- Raise the vehicle on a hoist and support the rear axle independently to relieve the tension on the leaf springs.
- 1. U-bolt nuts (7) and washers (8).
- 2. Anchor plate (9).
- 3. U-bolts (10) and spacer (11).
 - Loosen the shackle to spring nut (12).
- 4. Shackle (18) to rear bracket nut (15), washers (16) and bolt (17).
- 5. Spring to front bracket (23), nut (20), washers (21), and bolt (22).
- 6. Spring assembly (24) from the vehicle.

Install or Connect (Figures 3 and 4)

NOTICE: For steps 2, 3, 4, and 6, refer to "Notice" on page 3D-1.

1. Spring assembly (24) to the vehicle.
2. Spring to front bracket bolt (22), washers (21), and nut (20).
 - Do not tighten.
3. Shackle (18) to rear bracket bolt (17), nut (15), and washers (16).
 - Do not tighten.
4. Spacer (11) and **new** U-bolts (10) to the top of the spring.
5. Anchor plate (9).
6. Washers (8) and nuts (7).

Tighten (Figure 4 and 5)

- A. The nuts (7) in sequence to the torque listed in "Specifications".

Adjust (Figure 6)

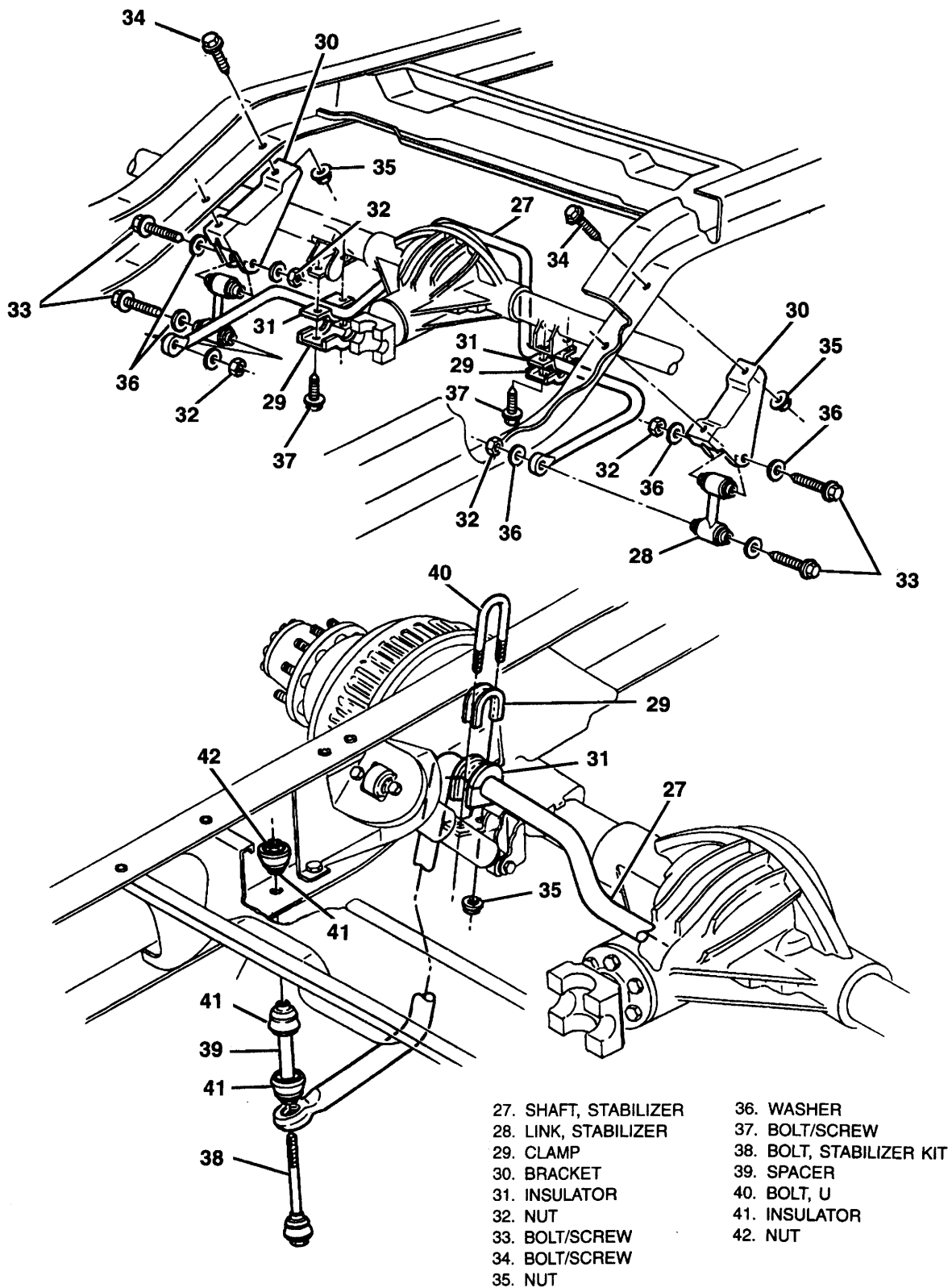
- The spring height to obtain a measurement of 182 mm (7 11/64 inches) between the top surface of the axle jounce pad and the bottom surface of the frame jounce bracket (figure 6).
- B. The front (20) and rear (12) spring and shackle (15) nuts to 110 N.m (81 lbs. ft.).

SHACKLE REPLACEMENT

Remove or Disconnect (Figures 2 and 3)

- Raise the vehicle on a hoist and support the rear axle independently to relieve the tension on the leaf springs.
- Loosen the shackle to spring nut (12).
- 1. Shackle (18) to rear bracket bolt (17), nut (15), and washers (16).
- 2. Shackle to spring nut (12), washers (13), and bolt (14).
- 3. Shackle (18) from the vehicle.

3D-4 REAR SUSPENSION



V3471

Figure 2—Stabilizer Shaft Components

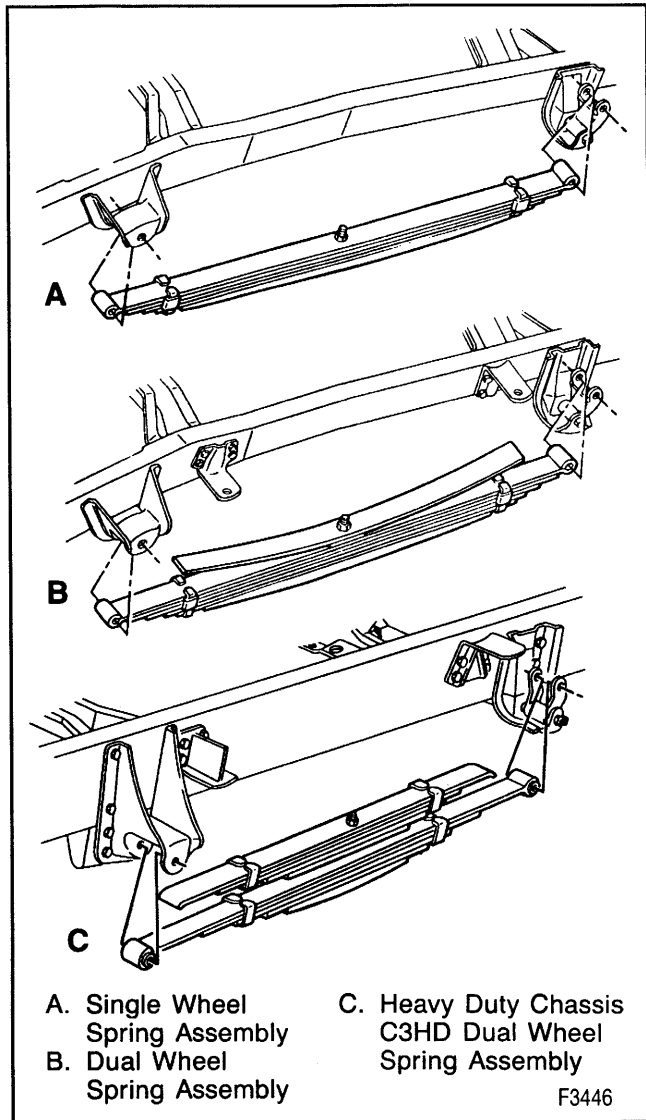


Figure 3—Single and Dual Wheel Leaf Springs

→→ Install or Connect (Figures 2 and 3)

NOTICE: For steps 2 and 3, refer to "Notice" on page 3D-1.

1. Shackle (18) to the vehicle.

2. Shackle to spring bolt (14), washers (13), and nut (12).

- Do not tighten.

3. Shackle to rear bracket bolt (17), nut (15), and washers (16).

- Do not tighten.



Adjust (Figure 6)

- The spring height to obtain a measurement of 182 mm (7 11/64 inches) between the top surface of the axle jounce pad and the bottom surface of the frame jounce bracket.



Tighten

- The front (20) and rear (12) spring nuts and the shackle nut (15) to 110 N.m (81 lbs. ft.).

BUSHING REPLACEMENT



Remove or Disconnect (Figure 4)

1. Spring assembly. Refer to "Leaf Spring Replacement."
2. Bushing from the leaf spring.
 - Place the leaf spring in a press and press the bushing out.
 - Clean the spring bushing bore of bits of old bushing, and burrs or corrosion.



Install or Connect (Figure 4)

1. Bushing to the leaf spring.
 - Place the leaf spring in a press and press the bushing in.
2. Spring assembly. Refer to "Leaf Spring Replacement."

3D-6 REAR SUSPENSION

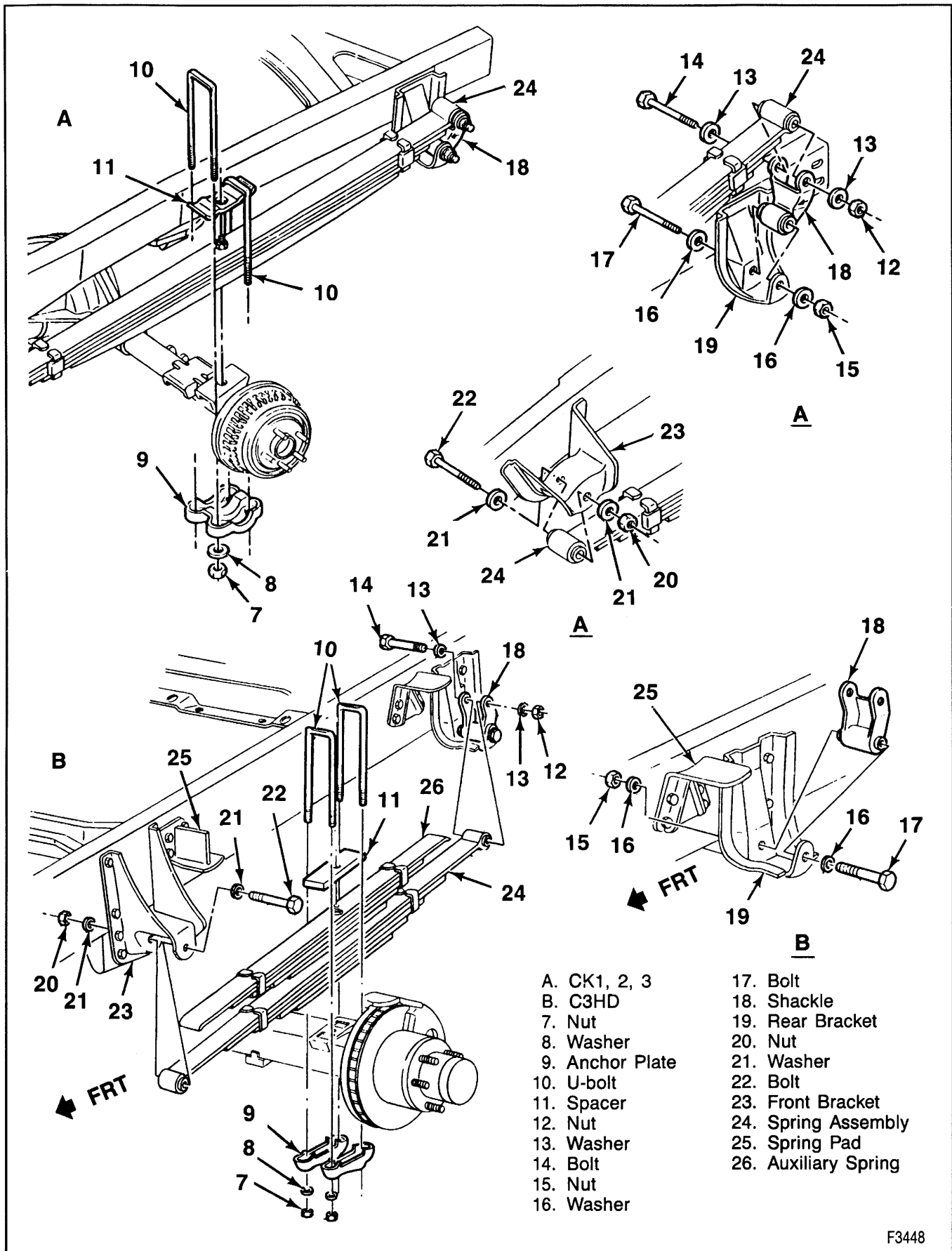


Figure 4—Axle Attaching Components

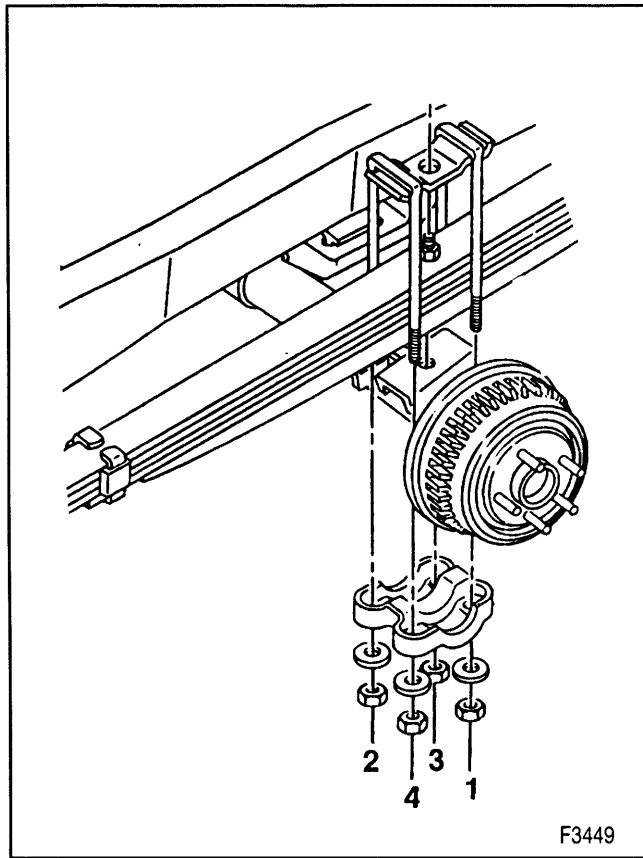


Figure 5—U-Bolt Tightening Sequence

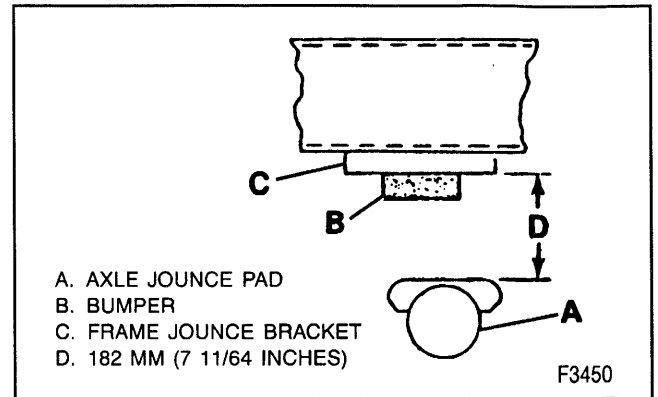


Figure 6—Rear Axle Trim Height

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

FASTENER	TORQUE	
	N·m	Ft. Lbs.
Leaf Spring to Bracket Nuts		
C/K 1, 2, 3	125	92
C3HD	435	320
Leaf Spring to Shackle Nuts		
C/K 1, 2, 3	110	81
C3HD	185	136
Shackle to Bracket Nuts		
C/K 1, 2, 3	110	81
C3HD	185	136
Shock Absorber Lower Nuts	110	81
Shock Absorber Upper Nuts		
C/K 1, 2, 3	27	20
C3HD	23	17
Stabilizer Clamp Bolt	34	25
Stabilizer Clamp U-Bolt Nut	30	22
Stabilizer Kit Nut	23	17
Stabilizer Link Nut	45	33
U-Bolt Nuts		
100 and 200 Models	110	81
300 Models without Dual Rear Wheels or 7.4L Engine	110	81
300 Models with Dual Rear Wheels or		
7.4 L Engine without Dual Rear Wheels	148	109
C3HD	280	207

T2104

SECTION 3E

TIRES AND WHEELS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The factory installed tires are designed to operate satisfactorily with loads up to and including the full rated load capacity when inflated to the recommended inflation pressures.

Correct tire pressures, wheel alignment, and driving techniques have an important influence on tire life. Heavy cornering, excessive rapid acceleration, and heavy braking will increase tire wear.

REPLACEMENT TIRES

A Tire Performance Criteria (TPC) specification number is molded in the sidewall near the tire size of all original equipment tires. This specification number ensures that the tire meets GM's performance standards for traction, endurance, dimension, noise, handling, rolling resistance, and others. Usually, a specific TPC number is assigned to each tire size.

Replacement tires should be the same size, load range, and construction as the original tires. Replace the original tires with tires of the same TPC specification number. Use of any other size or type tire may seriously affect ride, handling, speedometer/odometer calibration, vehicle ground clearance, and tire clearance to body chassis.

Note: 3500 HD models do not use TPC tires. Refer to the tire manufacturer for assistance.

CAUTION: Do not mix different types of tires such as radial, bias, and bias-belted tires. Vehicle handling may be seriously affected and may result in loss of control and possible personal injury.



Inspect

- Tires should be inspected and replaced when the following conditions are found:

1. They are worn to a point where 1.6 mm (1/16 inch) or less tread remains, or the cord or fabric is showing. To help detect this, tires may have built-in tread wear indicators that appear between the tread grooves when the tread is 1.6 mm (1/16 inch) or less. When the indicators appear in two or more adjacent grooves at three spots around the tire, replace the tire.
2. The tread or sidewall is cracked, cut or snagged deep enough to expose the cord or fabric.
3. The tire has a bump, bulge, or split. Slight sidewall indentations are normal and should not affect ride.

4. The tire has a puncture, cut, or other damage that cannot be correctly repaired because of the size or location of the damage.



Important

- It is recommended that new tires be installed in pairs on the same axle. If it is necessary to replace only one tire, pair it with the tire having the most tread.

ALL SEASONS TIRES

Some vehicles are now equipped with steel belted all season radial tires as standard equipment. These tires qualify as snow tires. They have a 37% higher average rating for snow traction than the non all season radial tires previously used. These tires are identified by an "M+S" molded in the tire sidewall following the size. The suffix "MS" is also molded in the sidewall after the TPC specification number.

P-METRIC TIRES

Most P-metric and LT-metric tires do not have exact corresponding alpha-numeric tire sizes. For example, a P205/75R15 is not equal in size and load carrying capacity to an FR78-15. For this reason, replacement tires should be of the same TPC specification number (same size, load range, construction) as those originally on the vehicle. If P-metric or LT-metric tires must be replaced with other sizes, a tire dealer should be consulted. Tire companies can best recommend the closest match. Refer to figure 1.

TIRE CHAIN USAGE

When chains are to be used, most current vehicles require SAE Class "S" or SAE Class "U" tire chains (figure 2). These may also be designated as 1100 Series, Type "PL," 1200 Series, Type "P," or 1800 Series Lug Reinforced tire chains. These chains are specially designed to limit the "fly off" effect that occurs when the wheel rotates.

Manufacturers of tire chains have a specific chain size for each tire size to ensure proper fit when installed. Therefore, be sure to purchase the correct chains for the tires on which they are to be used. Rubber adjusters should not be used to take up slack or clearance in chains that are loose due to incorrect size. Always follow the chain manufacturer's installation instruction.

Use of chains may adversely affect handling. When using chains:

- Ensure that the vehicle is designed for chain clearance.
- Adjust speed to road conditions.
- Avoid sharp turns.
- Avoid locked-wheel braking in general, to help prevent chain damage to the vehicle.
- Install the chains on the drive tires as tightly as possible, then tighten them again after driving 0.4 to 0.8 kilometer (1/4 to 1/2 mile). The use of chains on the non-drive tires is not recommended; the chains may contact and possibly damage the vehicle. If chains are used on the non-drive tires, make sure there is enough clearance.
- Do not exceed 70 km/h (45 mph) or the chain manufacturer's speed limit, if lower.
- Drive in a restrained manner and avoid large bumps, potholes, severe turns, and other maneuvers that could cause the tires to bounce up and down.
- Follow any other instructions of the chain manufacturer that do not disagree with the above.

TIRE PLACARD

The tire information label is permanently located on the rear face of the drivers door, and should be referred to for tire information. The label lists the maximum vehicle load, tire size (including spare), and cold inflation pressure (including spare). For further information, refer to SECTION 0A.

WHEELS

Wheels must be replaced if they are bent, dented, have excessive lateral or radial runout, leak air through the welds, have elongated bolt holes, or wheel nuts will not stay tight. Wheels with runout greater than specified may cause objectionable vibrations.

CHECKING WHEEL MOUNTING SURFACE



Inspect (Figures 3 and 4)

- Use a straight edge 8 to 9 inches long (figure 3). Place it on the inboard mounting surface of the wheel and try to rock it up and down.
- Repeat the above procedure on at least three or four different positions on the inboard mounting surface.
- The outer ring of the mounting surface is normally raised above everything inside it. If the wheel mounting surface has been bent on a tire changer, it will be raised above the outer ring (figure 3).
- Check mounting wheel/nut holes for damage that can be caused from over torquing the lug nuts. Look for collapsed wheel/nut bosses or cracked bosses (figure 4).

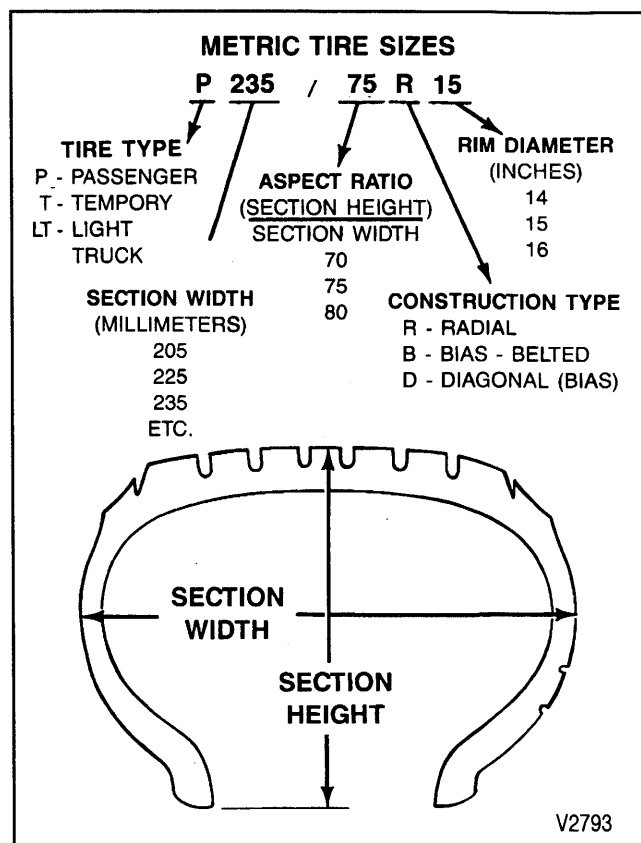


Figure 1—Tire Size Explanation

- If the wheel is bent or the wheel/nut boss area is cracked, replace the wheel.



Important

- Replacement wheels must be equivalent to the original equipment wheels in load capacity, diameter, rim width, offset, and mounting configuration. A wheel of incorrect size or type may affect wheel and hub bearing life, brake cooling, speedometer/odometer calibration, vehicle ground clearance, and tire clearance to the body and chassis.

Steel wheels can be identified by a two or three-letter code stamped into the front side rim near the valve stem. Aluminum wheels have the code, part number, and manufacturer's ID cast into the backside.

NOTICE: The use of aftermarket reverse-type wheels, designed to extend the wheel away from the body, will increase the scrub radius. An increased scrub radius may greatly increase steering effort and reduce hub bearing life.

3E-4 TIRES AND WHEELS

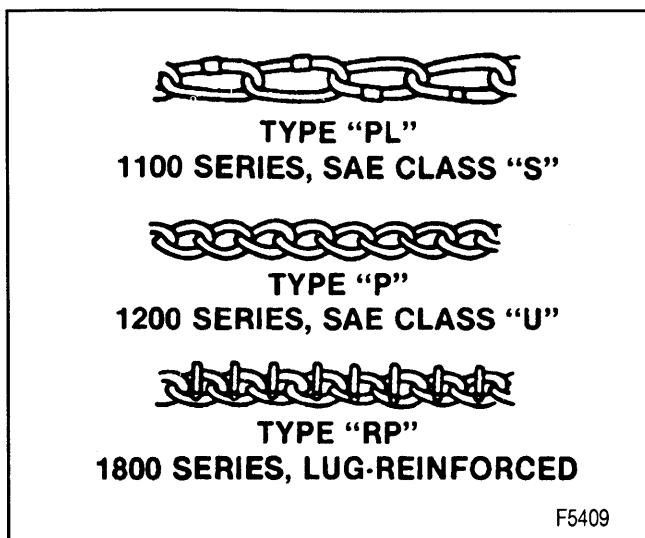
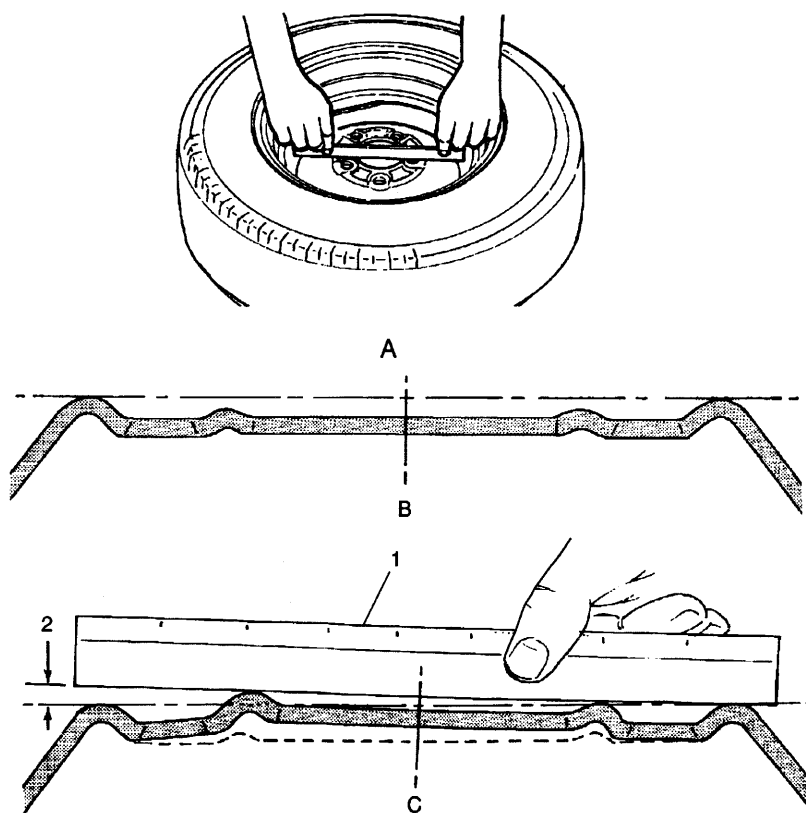


Figure 2—Tire Chain Types



- A. STRAIGHT EDGE CHECK
- B. ORIGINAL WHEEL MOUNTING SURFACE
- C. BENT WHEEL MOUNTING SURFACE
- 1. STRAIGHT EGDE
- 2. GAP

2903r4419

Figure 3—Checking Wheel Mounting Surface

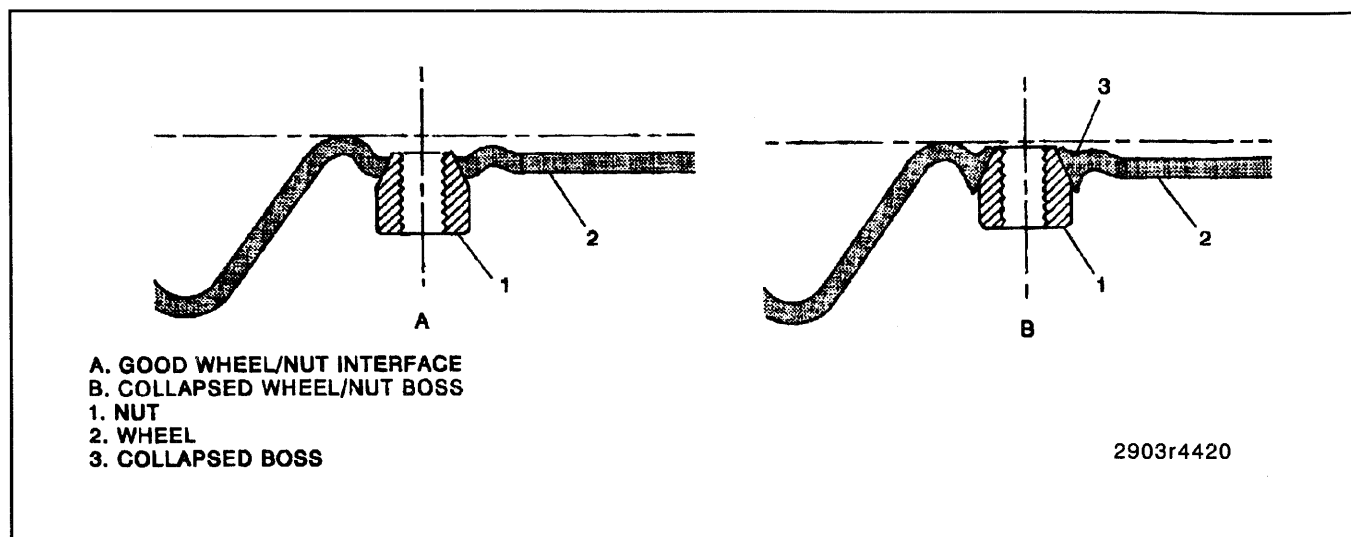


Figure 4—Checking Wheel/Nut Boss

DIAGNOSIS OF TIRES AND WHEELS

The following information (including figure 3) will help to identify certain tire-related durability and drivability problems.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Heel And Toe Wear	1. Hard cornering. 2. Incorrect alignment (excessive toe).	1. Correct as required. 2. Set to correct specifications.
Excessive Tire Edge(s) Wear	1. Underinflated tires. 2. Vehicle overloaded. 3. Hard cornering. 4. Incorrect toe setting.	1. Inflate to recommended pressure. 2. Refer to certification label. 3. Correct as required. 4. Set to correct specifications.
Excessive Tire Wear (Center Of Tread)	1. Overinflated tires. 2. Overloaded vehicle. 3. Rapid acceleration/excessive braking.	1. Deflate to recommended pressure. 2. Refer to certification label. 3. Correct as required.
Uneven Tire Wear	1. Improper tire pressure. 2. Incorrect tire and wheel usage. 3. Front end out of alignment. 4. Loose, worn, or damaged steering linkage, joints, suspension components, bushings and/or ball joints.	1. Inflate to recommended pressure. 2. Install correct tire-wheel combination. 3. Align the front end. 4. Inspect, repair or replace as required.
Radial Tire Waddle (Side To Side Movement At Speeds Between 5 and 15 MPH)	1. Excessive lateral runout (wheel). 2. Excessive lateral runout (tire).	1. Replace wheel. 2. Replace tire.
Vibration	1. Out of balance wheel/tire. 2. Tire runout. 3. Wheel runout. 4. Uneven tire wear.	1. Balance wheel/tire. 2. Replace tire. 3. Replace wheel. 4. Replace tire.

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ON-VEHICLE SERVICE

WHEEL REPAIR

Wheel repairs that use heating, welding, or peening are not approved. An inner tube is not an acceptable repair for leaky wheels or tires. If a wheel is found to be leaking, the wheel should be replaced with one of original equipment quality.

METRIC WHEEL NUTS AND BOLTS

Metric wheel nuts and bolts are identified as follows: The wheel nut has the word "Metric" stamped on the face. The letter "M" is stamped into the end of the wheel bolt.

The thread size of metric wheel nuts and bolts are indicated by the following example:

"M14 x 1.5"

M=Metric

14=Diameter in millimeters

1.5=Millimeters per thread (gap between)

TIRE INFLATION AND LOAD LIMITS

The factory installed wheels and tires are designed to handle loads up to and including their gross axle weight when inflated to the recommended inflation pressures.

Correct tire pressures, wheel alignment, and driving techniques have an important influence on tire life. Under-inflated tires can cause handling problems, poor fuel economy, shortened tire life, and tire overloading. Heavy cornering, excessive rapid acceleration, and heavy braking will increase tire wear.

Tire pressure, with tires cold (after vehicle has set for three hours or more, or driven less than one mile) should be checked monthly or before any extended trip and set to the specifications on the tire label.

Valve caps or extensions should be installed on the valves to keep out dust and water.

The metric term for tire inflation pressure is the kilopascal (kPa). Tire pressure may be printed in both kPa and psi. One psi equals 6.9 kPa (figure 6).

INFLATION PRESSURE CONVERSION CHART (KILOPASCALS TO PSI)			
kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60
Conversion: 6.9 kPa=1 psi			
T2567			

Figure 6—Inflation Pressure Conversion

Higher Than Recommended Pressure Can Cause:

- Hard ride.
- Tire bruising or carcass damage.
- Rapid tread wear at center of the tire.

Lower Than Recommended Pressure Can Cause:

- Tire squeal on turns.
- Hard steering.
- Rapid and uneven wear on the edge of the tread.
- Tire rim bruises and rupture.
- Tire cord breakage.
- High tire temperatures.
- Reduced handling.
- High fuel consumption.
- Soft ride.

Unequal Pressure On Same Axle Can Cause:

- Uneven braking.
- Steering lead.
- Reduced handling.

WHEEL REMOVAL

Penetrating oil has been found to be effective in removing tight wheels. However, if it is used it should be applied sparingly to the hub surface only.

CAUTION: If penetrating oil gets on the vertical surfaces between the wheel and the rotor or drum it could cause the wheel to work loose as the vehicle is driven, resulting in loss of control and an injury accident. Never use heat to loosen a tight wheel. It can shorten the life of the wheel, studs, or hub and bearing assemblies. Wheel nuts must be tightened in sequence and to the specified torque to avoid bending the wheel or rotor.

Sometimes wheels can be difficult to remove from the vehicle due to foreign material or a tight fit between the wheel center hole and the hub or rotor. Excessive force such as hammering the wheel or tire can cause damage and is not recommended. Slight tapping of the tire side wall with a rubber mallet is acceptable.

The wheel can be removed without damage as follows:

1. Tighten all the lug nuts on the affected wheel.
 - Do not torque.
2. Loosen each nut two turns.
3. Rock the vehicle from side to side to loosen the wheel. Or rock the vehicle from forward to reverse allowing the vehicle to move several feet in each direction. Apply quick, hard jabs on the brake pedal to loosen the wheel. If that did not free up the wheel, then rock the vehicle again from side to side as hard as possible using one or more person's body weight to loosen the wheel. If the wheel is still tight, repeat the procedure.

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WHEEL AND TIRE INSTALLATION

SINGLE WHEELS (FRONT OR REAR)



Remove or Disconnect

1. Raise vehicle and support with safety stands.
2. Hub cap, if required.
3. Wheel nuts.
 - Mark the location of tire and wheel assembly to hub assembly.
4. Tire and wheel assembly.

CAUTION: Before installing a wheel, remove any corrosion on the wheel mounting surface and brake drum or disc mounting surface by scraping and wire brushing. Installing wheels with poor metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen. This can lead to a wheel coming off while the vehicle is moving, possibly causing loss of control and personal injury.



Clean

- Wheel nuts, bolts, and the wheel and rotor mounting surfaces.

Notice: A torque wrench or J 39544 must be used to ensure that wheel nuts are tightened to specification. Never use lubricants or penetrating fluids on wheel stud, nuts, or mounting surfaces, as this can raise the actual torque on the nut with out a corresponding torque reading on the torque wrench. Wheel nuts, studs, and mounting surfaces must be clean and dry. Failure to follow these instructions could result in wheel, nut, and/or stud damage.



Install or Connect

Tool Required:

Suitable Torque Wrench
J 39544 - GM Wheel Nut Torque Adapters
(For uses with pneumatic impact)

1. Tire and wheel assembly.
 - Align locating mark of tire and wheel to hub assembly.
2. Wheel nuts.



Tighten

- Wheel nuts to "Specifications" at the end of this section.
 - Tighten evenly and alternately to avoid excessive runout (figure 7).
3. Hub cap, if required.
 4. Lower the vehicle.

DUAL REAR WHEELS



Remove or Disconnect

1. Raise vehicle and support with suitable safety stands.
2. Hub cap, if required.

3. Wheel nuts.
 - Mark location of tire and wheel assembly to hub assembly.
4. Clamp ring and outer and inner wheel.



Install or Connect

1. Inner and outer wheel and clamp ring.
 - Make sure the pins on the clamp ring face outward.
2. Wheel nuts.



Tighten

- Nuts to "Specifications" listed at the end of this section.
 - Tighten evenly and alternately to avoid excessive runout (figure 7).
3. Hub cap, if required.
 4. Lower the vehicle.

TIRE ROTATION

To equalize wear, rotate tires at intervals specified in SECTION 0B. In addition to scheduled rotation, the tire and wheel assembly should be rotated whenever uneven tire wear is noticed (figure 8).

Due to their design, radial tires tend to wear faster in the shoulder area, particularly in front positions. Radial tires in non-drive locations may develop an irregular wear pattern that can generate tire noise. This makes regular rotation especially necessary.

TIRE MOUNTING AND DISMOUNTING

Use a tire changing machine to mount or dismount tires. Follow the manufacturer's instructions. Do not use hand tools or tire irons to change a tire as they may damage the tire bead, or wheel rim flanges.

Rim bead seats should be cleaned with a wire brush or coarse steel wool to remove old rubber and light rust or corrosion. Before mounting or dismounting a tire, the bead area should be cleaned and well lubricated.

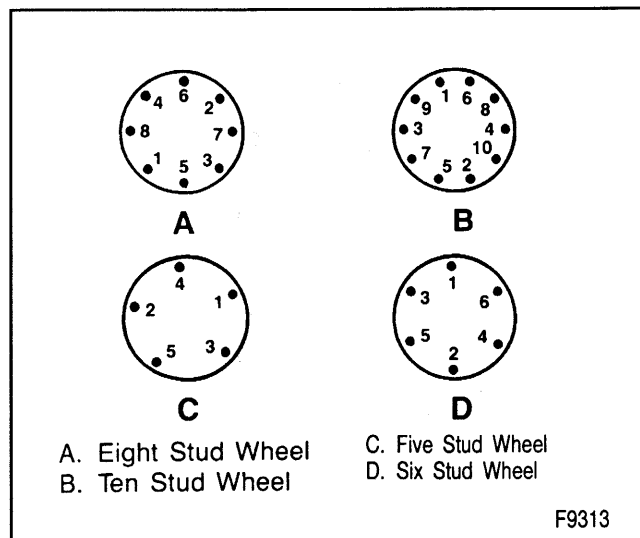


Figure 7—Wheel Nut Tightening Sequence

CAUTION: Do not stand over the tire when inflating. The bead may break when it snaps over the safety hump, and cause serious personal injury. Do not exceed 275 kPa (40 psi) pressure when inflating. If 275 kPa (40 psi) pressure will not seat beads, deflate, re-lubricate, and re-inflate. Overinflation may cause the bead to break and result in personal injury.

Notice: It is important to note that damage to either the tire mounting surface or the wheel mounting holes can result from the use of improper wheel attachment or tire mounting techniques. It takes 70 seconds for all the air to completely exhaust from a large tire. Failure to follow proper procedures could cause the tire changer to put enough force on the tire to bend the wheel at the mounting surface. Such damage may result in vibration and/or shimmy and under severe use lead to cracking

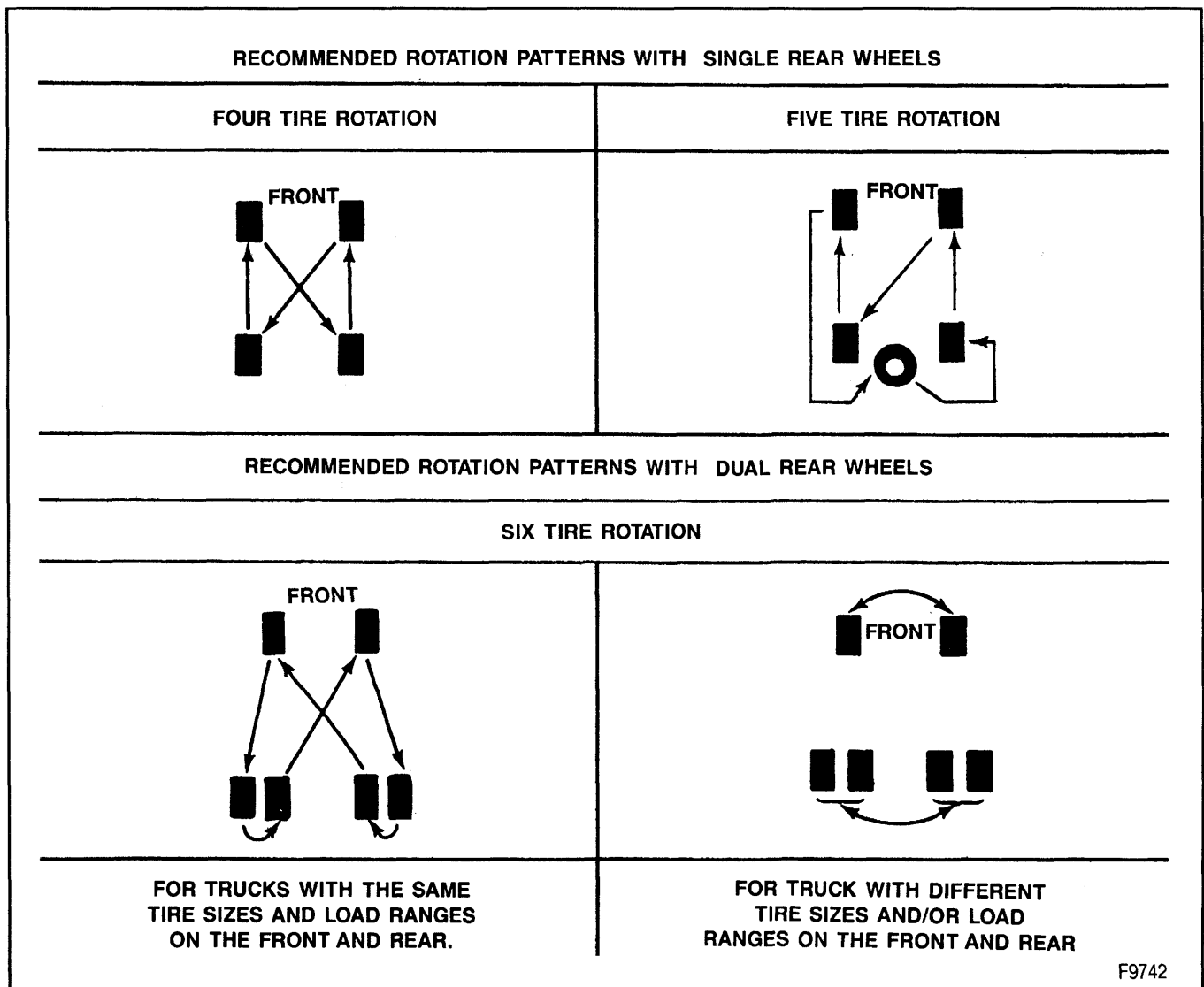
Install the valve core and inflate to proper air pressure. Check the locking rings of the tire to make sure they show around the rim flanges on both sides of the wheel.

TIRE REPAIR

There are many different materials and techniques on the market to repair tires. Not all work on some types of tires. Tire manufacturer's have published detailed instructions on how and when to repair tires. The instructions can be obtained from the tire manufacturer.

CHECKING WHEEL AND TIRE RUNOUT

Some vehicles are sensitive to tire and wheel assembly runout. Tires that are satisfactory on one vehicle might be unsatisfactory on another. When analyzing vibration problems, it is important to keep this in mind. In addition, different wheel positions on a vehicle may



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Figure 8—Tire Rotation Pattern

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have different sensitivity levels. You should check for wheel runout or total wheel and tire runout in the following cases:

- A. If the tire and wheel vibration occurs below 40 miles per hour.
- B. If all wheels are balanced and a vibration occurs.
- C. If there appears to be a bulge in a tire or an out-of-round condition as a tire rotates on a balancer.
- D. If any wheel damage is noticed.
- E. If there is a poor wheel fit on the hub and the vehicle exhibits vibration.

MEASURING WHEEL AND TIRE RUNOUT

Wheel runout should be measured with an accurate dial indicator. Measurements may be taken with the wheel installed on the vehicle, or off the vehicle using an accurate mounting surface such as a wheel balancer. Measurements may also be taken with or without the tire mounted on the wheel.

Radial runout and lateral runout should be measured on both the inboard and outboard rim flanges. With the dial indicator firmly in position, slowly rotate the wheel one revolution and record the total indicator reading. If any measurement exceeds specifications, and there is a vibration that wheel balancing will not correct, the wheel should be replaced. Disregard any indicator readings due to welds, paint runs, scratches, etc.

RADIAL RUNOUT

Radial runout is the egg-shaped difference from a perfect circle. Measure tire radial runout from the center tire tread rib although other tread ribs can be measured as well. The total runout is the reading from the gage, and the high spot is the location of the maximum runout. On a rim, if either flange is beyond specifications, replace the rim (figure 9).

- Aluminum Wheels—0.762 mm (0.030 inch)
- Steel Wheels—1.015 mm (0.040 inch)

LATERAL RUNOUT

Lateral runout is a sideways variation causing a twist or wobble and is measured on a side surface. On the tire and wheel assembly, measure the sidewall of the tire as close to the tread shoulder design edge as possible. The total runout is the reading from the gage, and the high spot is the location of the maximum runout. On a rim, if either flange is beyond guidelines, replace the rim (figure 10).

- Aluminum Wheels—0.762 mm (0.030 inch)
- Steel Wheels—1.143 mm (0.045 inch)

MEASUREMENT PROCEDURES

1. Inflate the tires to specifications.
2. Warm up the tires prior to taking measurements to eliminate flat spotting.
 - Newly installed tires usually do not require warming up.
3. Raise vehicle and support with safety stands.
 - If measurements will be taken off the vehicle, mount each tire and wheel assembly on a dynamic balance machine.

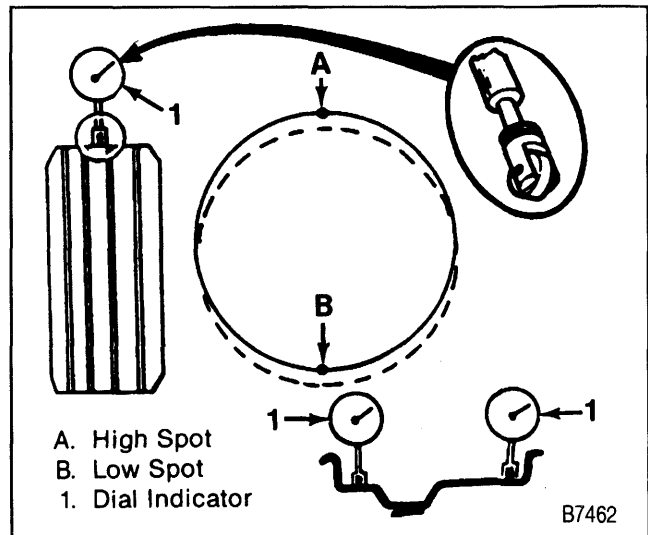


Figure 9—Measuring Radial Runout

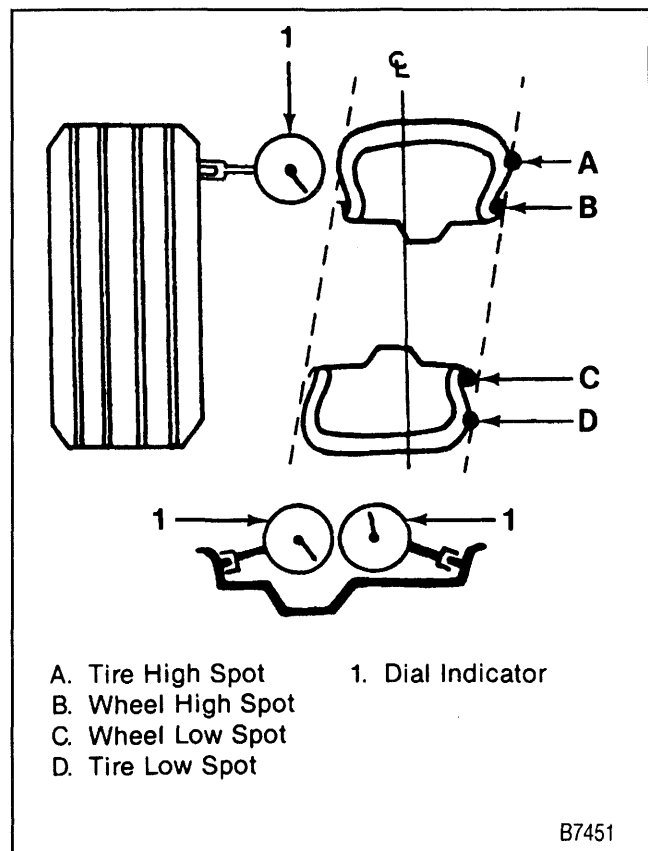


Figure 10—Measuring Lateral Runout

4. Mark the tire and wheel assemblies for exact replacement.
 - A. Mark a wheel hub bolt and its exact position on the wheel.
 - B. Mark each tire and wheel assembly for replacement on the exact hub/rotor assembly.
5. Take either a radial or lateral runout measurement.
 - A. Place the dial indicator in position.
 - B. Rotate the tire and wheel assembly (or just the wheel) to find its low spot. Adjust the dial indicator to read zero.

- C. Rotate again to verify the low spot location—the dial indicator must return to zero.
 - D. Disregard any instantaneous dial jumps due to welds, paint runs, scratches, etc. on the wheel.
 - E. Rotate the tire and wheel assembly (or just the wheel) and note the amount of variance (runout) from zero. Locate and mark the high spot.
6. If there is a large difference in runout measurements from ON vehicle to OFF vehicle, the runout problem is likely due to excessive runout of the bolt circle or hub.
 7. If measured runouts are not within the guidelines located in “Wheel Runout Specifications” at the end of this section, proceed to “Vectoring” to correct the problem.

VECTORING

Vectoring is a technique used to reduce radial or lateral runout—and even dynamic balance on tire and wheel assemblies. Vectoring can be accomplished by the positioning of the tire on the wheel and the positioning of the tire and wheel assembly on the hub/rotor.



Important

- Always rebalance the tire and wheel assembly after vectoring.

Tire To Wheel Vectoring

1. Determine which runout needs to be minimized.
 - Determine visually.
2. If radial runout is the problem, take a measurement on the center tread rib.
 - If the trend is uneven, wrap tape tightly around the tire, record the runout magnitude, and mark the high spot location (figure 11).
3. If lateral runout is the problem, take a measurement on the sidewall just below the edge of the tread shoulder.
 - Record the runout magnitude, and mark the high spot location.
4. Mark the tire sidewall at the valve location.
 - A. This is the 12 o'clock position.
 - B. The location of the high spot is always with respect to the clock location on the wheel.
5. Break the tire and wheel assembly down on a tire mounting machine and rotate the tire 6 hours (180 degrees) on the rim (figure 12).
 - A. Reinflate the tire and measure the runout in question.
 - B. Record the magnitude and the location of the high spot (Valve stem is 12 o'clock.).
6. If the clock location of the high spot remained at or near the clock location of the original high spot, the rim is the major contributor to the runout problem.
 - A. Confirm by removing the tire from the wheel and check the wheel rim runout.
 - B. If the wheel rim runout exceeds guidelines, replace the wheel.
7. If the clock position of the high spot is 6 hours from the original high spot, the tire is the major contributor to the runout problem (figure 12).
 - Replace the tire.

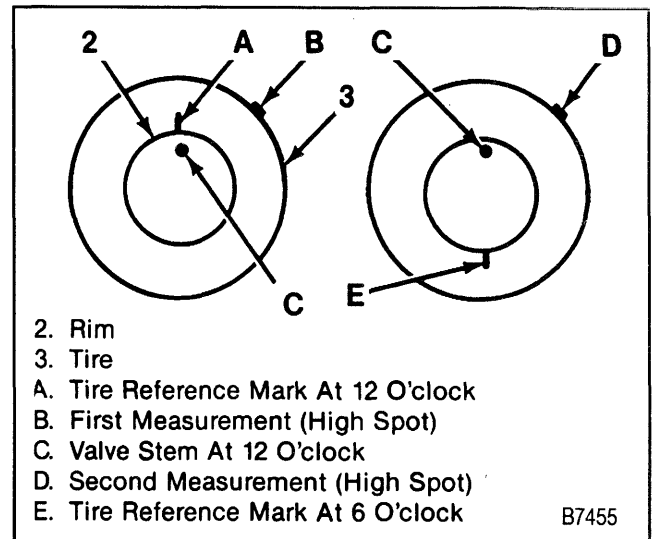


Figure 11—Checking Tire to Wheel Vectoring

8. After correcting the tire to the wheel vectoring, rebalance the wheel and tire assembly.

Tire And Wheel Assembly To Hub/Rotor Vectoring

1. Mark the wheel hub bolt nearest the valve stem for reference (figure 13).
2. Rotate the tire assembly two wheel hub bolts and recheck the runout (figure 13).
 - Several positions may have to be tried to locate the optimum location.
 - This can be effective for both radial and lateral runouts.
3. If there is some looseness in the wheel hub bolt holes, radial runout can be reduced by loosening the hub bolt nuts slightly, moving the wheel position on the bolts and then retightening the nuts.
4. Balance the tire and wheel to hub/rotor assembly.
 - Compensates for any imbalance in the brake rotor, drum, or wheel cover.

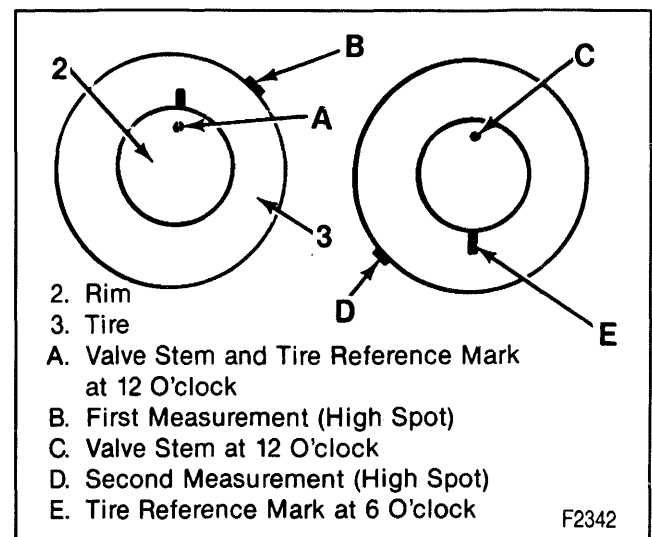


Figure 12—Tire to Wheel Vectoring—Excessive Tire Runout

3E-12 TIRES AND WHEELS

BALANCING TIRE AND WHEEL

There are two types of tire and wheel balancing, static and dynamic. Static balance is the equal distribution of weight to the inboard and outboard rim flanges (splitting) at one location on the wheel. Assemblies that are statically unbalanced cause a bouncing action called wheel tramp (figure 14). This condition will eventually cause uneven tire wear.

Dynamic balance is the distribution of weight on each side of the centerline so that when the assembly spins there is no tendency for the assembly to move from side to side (figure 15). Assemblies that are dynamically unbalanced may cause wheel shimmy.

GENERAL BALANCE PRECAUTIONS

Deposits of foreign material must be cleaned from the inside of the wheel. Stones should be removed from the tread in order to avoid operator injury during spin balancing and to obtain a good balance. The tire should be inspected for any damage, then balanced according to the equipment manufacturer's recommendations.

OFF-VEHICLE BALANCING

When balancing tire and wheel assemblies off the vehicle, use a balancer that pilots the wheel by the

center hole (not the wheel bolt) if possible. Always follow the equipment manufacturer's instructions.

Some electronic off-vehicle balancers are more accurate than the on-vehicle spin balancers, but do not correct for rotor unbalance. If the vibration is not corrected by the off-vehicle balance, an on-vehicle balance may also be needed.

ON-VEHICLE BALANCING

When needed, on-vehicle balancing will help correct vibrations due to brake drum, rotor, and wheel cover imbalance.

When balancing on-vehicle remove the balance weights from the off-vehicle dynamic balance. If more than 28 grams (one ounce) of additional weight is required, it should be split between the inner and outer rim flange.

CAUTION: On vehicles equipped with limited slip rear axles, do not attempt to balance a tire on a drive wheel with the other drive wheel on the ground. The vehicle may drive through this wheel and cause the vehicle to move unexpectedly, resulting in personal injury and property damage.

NOTICE: The driven tire and wheel assemblies should be spun using the engine. Limit speed as stated in the following Caution.

CAUTION: Do not spin the drive wheels faster than 35 mph (55 km/h) as indicated by the speedometer. This limit is necessary because the speedometer indicates only one-half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Personal injury and damage may result from high speed spinning.

To distinguish between standard rear axle and a limited slip rear axle, check for Positraction (G80) on the Service Parts Identification label.

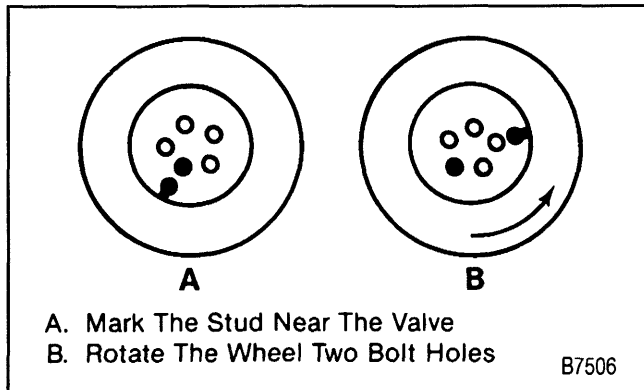


Figure 13—Tire and Wheel Assembly to Hub/Rotor Vectoring

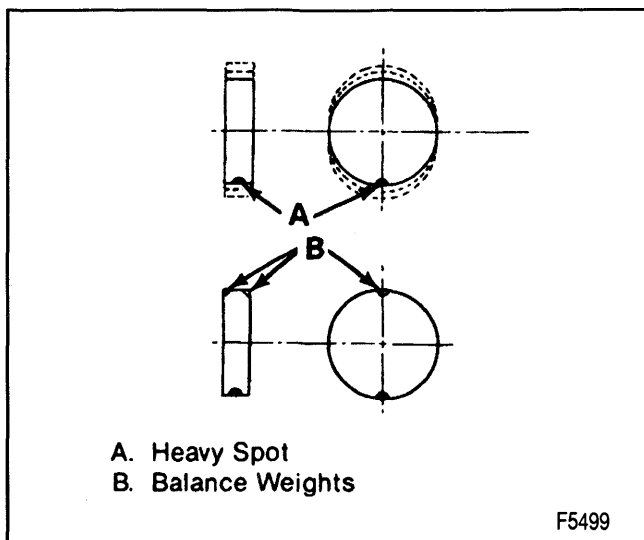


Figure 14—Static Unbalance

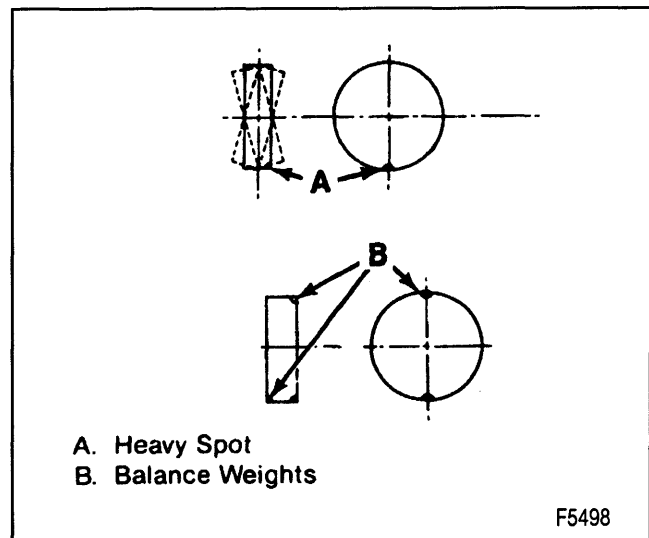


Figure 15—Dynamic Unbalance

WHEEL BALANCE WEIGHTS

If more than 28 grams (1 ounce) are needed when static balancing, the balance weights should be split as equally as possible between the inboard and outboard flanges.

Balancing of factory aluminum wheels requires the use of special polyester-coated clip-on type balance weights. These weights are designed to fit over the thicker rim flange of the aluminum wheel. They also provide a much better appearance and will not discolor, corrode, or damage the wheel.



Important

- When installing the polyester-coated weights, care must be used so the polyester coating does not crack. Use a teflon coated hammer.

Adhesive Wheel Balance Weight Installation

1. Wipe the wheel balance weight attachment area with a mixture of half isopropyl alcohol and half water. A clean cloth or paper towel must be used for this operation.
2. Dry the attachment area with hot air. Surface of the wheel should be warm to the touch.
3. The adhesive backing on the wheel balance weights must be warmed to room temperature.
4. Remove the tape from back of the weights. Do not touch the adhesive surface.
5. Apply the wheel balance weight and press on it with hand pressure.
6. Secure the wheel balance weight with a 70-110 N (16-25 lb.) force applied with a roller.

CORRECTING NON-UNIFORM TIRES

There are two ways to correct tires that cause a vibration even though they are properly balanced. One method uses an automatic machine that loads the tire and buffs small amounts of rubber from high spots on the outer two tread rows. Correction by this method is usually permanent and, if done properly, does not significantly affect the appearance or tire tread life. Tire trueing with a blade-type machine is not recommended as this reduces the tread life substantially and often does not permanently correct the problem.

Another method is to vector the tire and wheel assembly as previously explained.

ALUMINUM WHEELS

Aluminum wheels should be cleaned and waxed regularly. Do not use abrasive cleaners, as they could damage the protective coating.

HUB CAP



Remove or Disconnect

1. Tire and wheel assembly.
2. Place a block of wood approximately 50 mm (2 inches) in diameter with a squared off end against the back surface of the cap. A sharp hammer blow on the block of wood will remove the cap.



Install or Connect

NOTICE: Failure to hit the cap squarely without the load distributed evenly could result in permanent damage to the cap.

1. Place cap into position at wheel opening and place a block of wood at least 75 mm (3 inches) in diameter against cap face. Install the cap by striking the block of wood with a hammer.
2. Tire and wheel assembly.

POROSITY REPAIR

1. Remove the tire and wheel assembly.
2. Locate leaking areas by inflating tire to 345 kPa (50 psi) and dipping the tire and wheel assembly into a water bath.
3. Mark leak areas and remove the tire from the wheel.
4. Scuff the inside surface at leak area with 80 grit sandpaper and clean the area with general purpose cleaner such as 3M #08984 or equivalent.
 - Apply 3-mm (1/8-inch) thick layer of adhesive/sealant (GM P/N 1052366) or equivalent to the leak area and allow 12 hours of drying time.
5. Mount the tire on the wheel, pressurize to 345 kPa (50 psi) and check for leaks.

CAUTION: To avoid serious personal injury, do not stand over the tire when inflating. The bead may break when the bead snaps over the safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire if beads are not seated. If 275 kPa (40 psi) pressure will not seat the beads, deflate, relubricate the beads and reinflate. Overinflation may cause the bead to break and cause serious personal injury.

6. Adjust tire pressure to meet specifications.
7. Balance the tire and wheel assembly.
8. Install the tire and wheel assembly.

REFINISHING

A protective clear coating is applied to the surface of original equipment cast aluminum wheels. A surface degradation condition can begin to develop if frequent, repeated automatic car wash cleaning abrades or wears off the factory applied protective clear coating. This can happen at some automatic car wash facilities using aggressive silicon carbide tipped tire brushes to clean white walls and tires. Once the protective clear coating is damaged, exposure to caustic cleaners and/or road salt further causes surface degradation. The following procedure details how to strip, clean, and recoat aluminum wheels that are affected by these conditions.

- A. Mark the wheel and tire for position on the vehicle and remove.
- B. Mark the position of the wheel weights and remove. Note: It is not necessary to remove the tire from the wheel to perform this procedure. However, if the tire is removed, its position to the wheel must be marked using the valve stem as an index. When

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remounting, the tire should be returned to its original position on the wheel.

- C. Wash the wheel inside and out with a water base all purpose cleaner. Remove grease and oil with a solvent cleaner.

Accent Color Preparation

- Sand over painted areas that will not require recoloring with 400 grit (wet or dry) to promote adhesion of the clear coat.

Surface Damage, Clear Coat Damage

- Mount the wheel on a brake lathe and spin slowly. sand the wheel with a backing block or pad while holding the abrasive flat to the surface of the wheel and moving slowly back and forth from center to outer edge to remove imperfections.

1. Sand with 80 grit
2. Sand with 150 grit
3. Sand with 240 grit

- Never use abrasives coarser than 80 grit.

Slight Clear Coat Damage on Unpainted Wheels

1. Remove the original clear coating.
 - A. Apply a chemical stripper to the wheel surface and allow the chemical to penetrate the coating.
 - B. Remove the stripper following the manufacturer's recommendations.
 - C. Rinse the wheel surface thoroughly with clean water.

CAUTION: Use of eye goggles is necessary to prevent personal injury.

2. Remove surface oxidation.
 - Sand the wheel with 240 grit (wet or dry) while rotating the wheel on a slow spinning brake lathe or by mounting it on the vehicle and spinning the wheel by hand. This should restore the machined appearance and promote adhesion.

CAUTION: Do not use vehicle power to rotate wheel while sanding to avoid serious personal injury.

3. Recoat the wheels.
 - A. Clean the surface of any contaminants by washing with soap and water.
 - B. Spray the wheel with Amchem #33 or equivalent and let soak 1 to 3 minutes.
 - C. Rinse with water and blow dry.
 - D. Mask the tire off.
 - E. Finish with Ditzler Delclear acrylic urethane and Ditzler Ultra urethane additive or equivalent. Three coats:
 - 1st coat - Light mist coat, let flash.
 - 2nd coat - Light, let flash.
 - 3rd coat - Heavy, double wet coat.
 - F. Let dry for 24 hours or if necessary, flash for 30 minutes, force dry at 140° F (60° C) for 30 minutes, and allow to cool for 30 minutes before mounting.

- G. Rebalance the tire and wheel assembly by replacing the original balance weights with polyester coated weights.

- H. Mount the weights in the marked positions and remove the masking from the tire.

SPARE TIRE MOUNTING

Spare tire mounting for Suburban and Utility models is at the left rear wheel well. The Utility uses a bracket for retention while the Suburban uses a mount that is part of the body.

SPARE TIRE CARRIER SUPPORT

The spare tire carrier support is required on all vehicles with 16-inch wheels. The bracket attaches to the frame side rails with one nut and bolt on each end of the bracket (figure 16).

SPARE TIRE BOX STOWAGE

The box mount is available for Fleetside box models except those with dual wheels (figure 17).

SPARE TIRE HOIST AND SHAFT

Spare wheel mounting for Pickup models is behind the rear axle and forward of the rear bumper using a winch/cable hoist system for stowage (figure 18).

Installation of the hoist assembly to the rear frame crossmember, required fasteners, etc., is the same for all vehicles except for a shorter hoist extension shaft on (1/2 ton) C/K models and two (2) distinct hoist assemblies:

- One hoist for all C/K (1/2—3/4 ton) models.
- One hoist for all C/K (1 ton) models.

Hoist is the same as C/K (1/2—3/4 ton) models hoist except for a larger wheel retainer plate which is forced by a larger pilot hole in C/K (1 ton) models wheels.

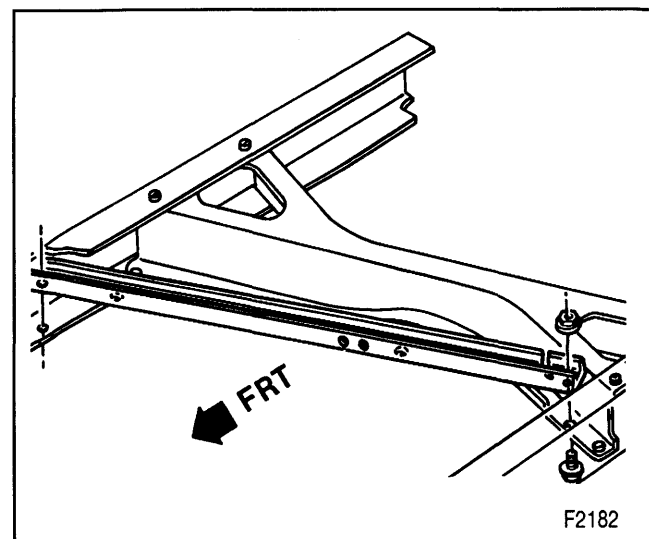
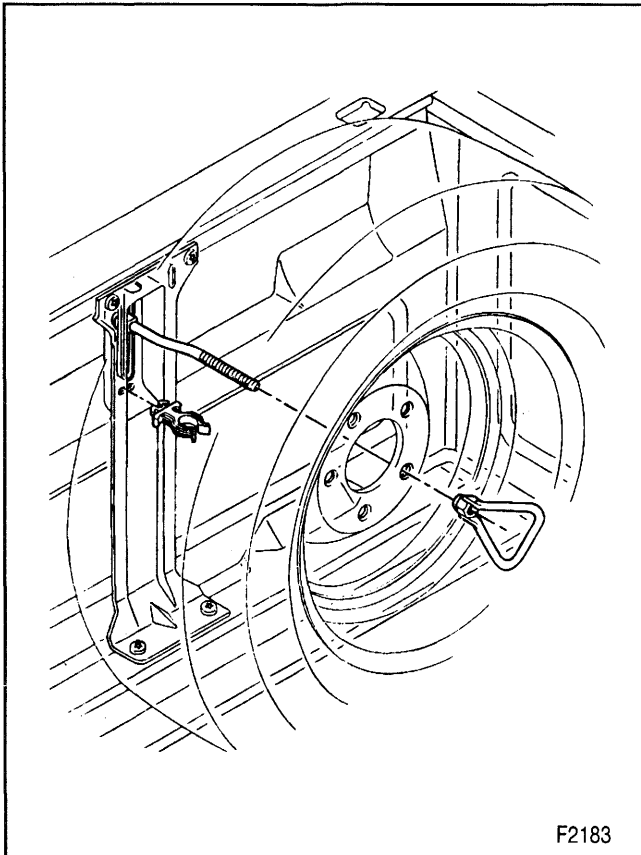
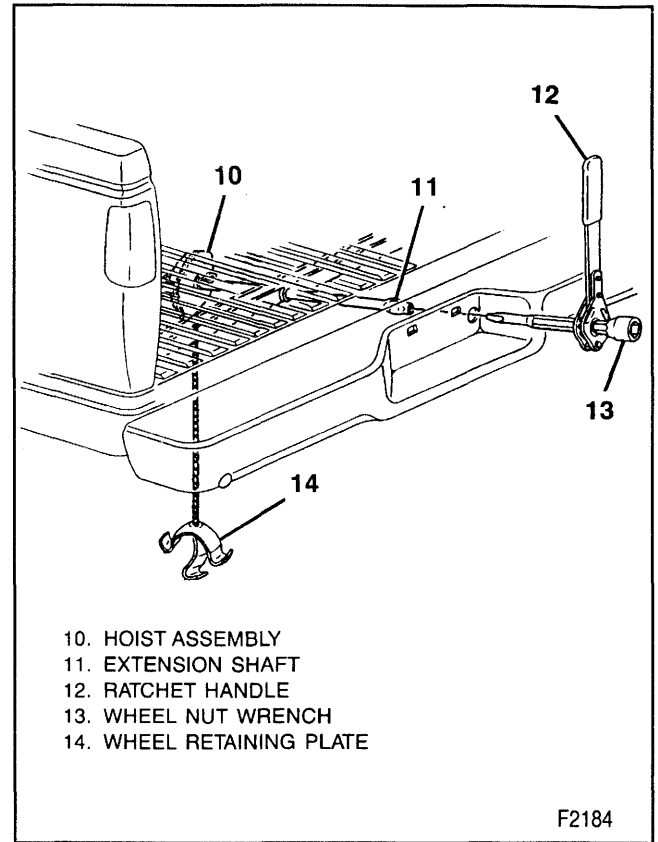


Figure 16—Spare Tire Carrier Support


Figure 17—Spare Tire Stowage

Figure 18—Spare Tire Hoist and Shaft

SPECIFICATIONS

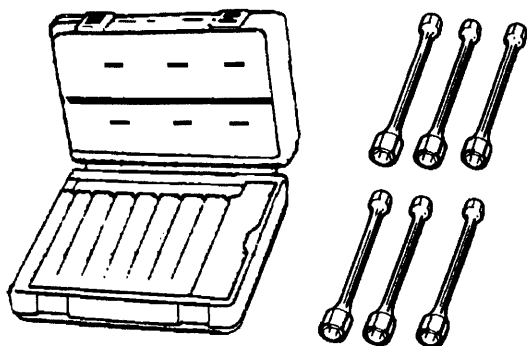
WHEEL STUD NUT TORQUE

SERIES	NUMBER OF STUDS	NUT TORQUE
C1	5	160 N.m (120 ft. lbs.)
CK1,2	6	160 N.m (120 ft. lbs.)
CK2,3 (Single)	8	160 N.m (120 ft. lbs.)
CK3 (Dual)	8	190 N.m (140 ft. lbs.)
C3HD (Dual)	10	240 N.m (175 ft. lbs.)

WHEEL RUNOUT

	STEEL WHEELS	ALUMINUM WHEELS
Radial Runout	1.01 mm (0.04 inches)	0.76 mm (0.03 inches)
Lateral Runout	1.14 mm (0.045 inches)	0.76 mm (0.03 inches)

SPECIAL TOOLS



**J 39544 – GM
WHEEL NUT TORQUE
ADAPTERS (Use with
pneumatic impact wrench not
exceeding 250 Ft. Lbs.)
includes: J 39544 – 12, J 39544 – 13
J 39544 – 14, J 39544 – 13, and
J 39544 – CSE**

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SECTION 3F

STEERING WHEEL AND COLUMN ON-VEHICLE SERVICE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The steering wheel and column components include a steering wheel, horn pad, steering column, and brackets.

The locking, energy-absorbing, steering column includes three important features in addition to the steering function.

1. The column is energy-absorbing, designed to compress in a front-end collision to minimize the possibility of injury to the driver of the vehicle.
2. The ignition switch and lock are mounted conveniently on the column.
3. With the column mounted lock, the ignition, steering, and gearshifting operation can be locked to inhibit theft of the vehicle.

The column may be disassembled and reassembled. To ensure the energy absorbing action, it is important that the specified screws, bolts, and nuts be used only

as designated and they are tightened to the specified torque.

NOTICE: When the column is removed from the vehicle, actions such as a sharp blow on the end of the steering shaft or shift lever, leaning on the column assembly, or dropping the assembly could shear or loosen the plastic fasteners that maintain column rigidity.

IGNITION LOCK SYSTEM

All column shift automatic transmissions vehicles contain a mechanical neutral safety start system. This system relies on a mechanical block to prevent starting the engine in any gear other than "PARK" or "NEUTRAL."

3F-2 STEERING WHEEL AND COLUMN ON-VEHICLE SERVICE

The mechanical block is a wedge-shaped lock bolt added to the the ignition switch actuator rod.

In either "PARK" or "NEUTRAL" the wedge-shaped lock bolt passes through slots in the shift bowl, allowing the lock cylinder set to turn and start the engine.

DIAGNOSIS OF THE STEERING COLUMN

PROBLEM	POSSIBLE CAUSE	CORRECTION
Lock System Will Not Unlock	1. Lock bolt damaged. 2. Faulty lock cylinder. 3. Damaged housing. 4. Damaged or collapsed sector. 5. Damaged rack.	1. Replace the lock bolt. 2. Replace or repair the lock cylinder. 3. Replace the housing. 4. Replace the sector. 5. Replace the rack.
Lock System Will Not Lock	1. Lock bolt spring is broken. 2. Damaged sector tooth. 3. Faulty lock cylinder. 4. Damaged housing. 5. Damaged rack. 6. Interference between the bowl and coupling. 7. Ignition switch stuck. 8. Actuator rod restricted or bent. 9. Transmission linkage adjustment incorrect.	1. Replace the spring. 2. Replace the sector tooth. 3. Replace the lock cylinder. 4. Replace the housing. 5. Replace the rack. 6. Adjust or replace. 7. Adjust or replace. 8. Adjust or replace. 9. Adjust.
Lock System—High Lock Effort	1. Lock cylinder is faulty. 2. Ignition switch is faulty. 3. Rack preload spring is broken or weak. 4. Burrs on the sector, rack, housing, support, tang of the shift gate, or actuator rod coupling. 5. Bent sector shaft. 6. Distorted rack. 7. Misalignment of the housing to the cover (tilt only). 8. Distorted coupling slot in the rack (tilt only). 9. Bent or restricted actuator rod. 10. Ignition switch mounting bracket is bent.	1. Replace the lock cylinder. 2. Replace the ignition switch. 3. Replace the spring. 4. Remove the burrs. 5. Replace the shaft. 6. Replace the rack. 7. Replace either or both. 8. Replace the rack. 9. Straighten or replace the rod. 10. Straighten or replace the bracket.
Lock Cylinder—High Effort Between The "Off" and "Off-Lock" Positions	1. Burr on tang of shift gate. 2. Distorted rack.	1. Remove the burr. 2. Replace the rack.
Sticks in "Start" Position	1. Actuator rod is deformed. 2. Any high effort condition.	1. Straighten or replace the rod. 2. See "correction" under the high effort diagnosis.
Key Cannot Be Removed In The "Off-Lock" Position	1. Ignition switch is not set correctly. 2. Faulty lock cylinder.	1. Adjust ignition switch. 2. Replace the lock cylinder.
The Lock cylinder Can Be Removed Without Depressing The Retainer	1. Faulty retainer. 2. Burr over the retainer slot in the housing cover.	1. Replace the lock cylinder. 2. Remove the burr.
Lock Bolt Hits The Shaft Lock In The "Off" And "Park" Positions	Ignition switch is not set correctly.	Adjust the ignition switch.

DIAGNOSIS OF THE STEERING COLUMN (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noise In The Column	1. Flexible coupling pulled apart. 2. Column not correctly aligned. 3. One click in Off-Lock position and when the steering wheel is moved. 4. Horn contact ring not lubricated. 5. Lack of grease on the bearings or bearing surface. 6. Lower shaft bearing is tight or frozen. 7. Upper shaft bearing is tight or frozen. 8. Lock plate retaining ring is not seated. 9. Steering shaft snap ring is not seated. 10. Shroud or housing is loose. 11. Sheared steering shaft plastic joint.	1. Align the column and replace the flexible coupling. 2. Align the column. 3. Normal seating of the lock bolt. 4. Lubricate. 5. Lubricate the bearings. 6. Replace the bearing. Inspect the shaft and replace if scored. 7. Replace the housing assembly. 8. Replace the retaining ring. Inspect for proper seating in the groove. 9. Replace the snap ring. Inspect for proper seating in the groove. 10. Tighten mounting screws. 11. Repair or replace the steering shaft. Align the column.
High Steering Shaft Effort	1. Column assembly is misaligned in the vehicle. 2. Tight or frozen upper or lower bearings. 3. Binding intermediate shaft joints.	1. Align correctly. 2. Replace the bearings. 3. Repair or replace the intermediate shaft.
High Shift Effort	1. Column assembly is misaligned in the vehicle. 2. Lower bowl bearing is not aligned correctly. 3. Lack of grease on the bearing or seal areas. 4. Shift tube is bent or broken.	1. Align correctly. 2. Align correctly. 3. Lubricate bearings and seals. 4. Replace the shift tubes.
Improper Transmission Shifter	1. Sheared shift tube joint. 2. Improper transmission linkage adjustment. 3. Loose lower shift lever. 4. Sheared lower shift lever weld.	1. Replace the shift tube assembly. 2. Adjust the linkage. 3. Replace the shift tube assembly. 4. Replace the shift tube assembly.
Lash In Mounted Column Assembly	1. Column mounting bracket bolts loose. 2. Broken weld nuts on the jacket. 3. Column bracket capsule sheared. 4. Loose shoes in the housing (tilt only). 5. Loose tilt head pivot pins (tilt only). 6. Loose support screws.	1. Tighten to specifications. 2. Replace the jacket assembly. 3. Replace the bracket assembly. 4. Replace the shoes. 5. Replace the pivot pins. 6. Tighten to specifications.
Excessive Play In The Mounted Steering Column Assembly (Tilt Column)	1. Column mounting bracket bolts loose. 2. Loose support screws. 3. Loose tilt head pivot pins. 4. Loose lock shoe pin in the support.	1. Tighten to specifications. 2. Tighten to specifications. 3. Replace the pivot pins. 4. Replace the pin.

3F-4 STEERING WHEEL AND COLUMN ON-VEHICLE SERVICE

DIAGNOSIS OF THE STEERING COLUMN (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Housing Loose (Tilt Column)	1. Excessive clearance between the holes in the support or the housing and pivot pin diameter. 2. Faulty anti-lash spring in the centering spheres. 3. Upper bearing not seating in the bearing race. 4. Upper bearing inner race seat missing. 5. Bearing preload spring broken. 6. Loose support screws.	1. Replace either or both. 2. Replace the spring. 3. Replace both. 4. Install the seat. 5. Replace preload spring. 6. Tighten to specifications.
Housing Scraping On The Bowl (Tilt Column)	Bowl bent or not concentric with the hub.	Replace the bowl and align to hub.
Steering Wheel Loose Every Other Tilt Position (Tilt Column)	Loose fit between the lock shoe and pivot pin.	Replace both.
Steering Column Will Not Lock In Any Tilt Position (Tilt Column)	1. Lock shoe grooves may have burrs or dirt. 2. Lock shoe spring is weak or broken. 3. Lock shoe seized on its pivot pin.	1. Replace lock shoes and clean the grooves. 2. Replace the spring. 3. Replace both lock shoes.
Noise When Tilting The Column (Tilt Column)	1. Tilt spring rubbing in the housing. 2. Tilt bumpers are worn.	1. Reposition and lubricate spring. 2. Replace the tilt bumpers.
Steering Wheel Fails To Return To Top Tilt Position (Tilt Column)	1. Pivot pins are bound up. 2. Tilt spring is faulty. 3. The turn signal switch wires are too tight.	1. Replace the pivot pins. 2. Replace the spring. 3. Reposition the wires.
Dimmer Switch Will Not Function	1. Loose connector at the dimmer switch. 2. Improper adjustment. 3. Internally damaged or worn switch.	1. Tighten or replace. 2. Readjust. 3. Replace.
Turn Signal Will Not Cancel	1. Loose switch mounting screws. 2. Switch or anchor bosses broken. 3. Broken, missing, or out of position detent, return or cancelling spring. 4. Uneven or incorrect cancelling cam to cancelling spring interference.	1. Tighten screws. 2. Replace the switch. 3. Reposition or replace the springs as required. 4. Adjust the switch position. • If the interference is correct and switch will still not cancel, replace the switch. • If the interference cannot be corrected by the switch adjustment, replace the cancelling cam.
Turn Signal Difficult to Operate	1. Switch actuator arm loose. 2. Yoke broken or distorted. 3. Loose or misplaced springs. 4. Foreign parts and/or materials. 5. Switch mounted loosely.	1. Tighten screw. 2. Replace the switch. 3. Reposition or replace the springs. 4. Remove the foreign parts and/or material. 5. Tighten screws.

DIAGNOSIS OF THE STEERING COLUMN (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Turn Signal Will Not Indicate Lane Change	1. Broken lane change pressure pad or spring hanger. 2. Broken, missing, or misplaced lane change spring. 3. Jammed base or wires.	1. Replace the switch. 2. Replace or reposition as required. 3. Loosen mounting screws, reposition base or wires and tighten the screws.
Turn Signal Will Not Stay In Turn Position	1. Foreign material or loose parts impeding movement of the yoke. 2. Broken or missing detent or cancelling springs. 3. None of the above.	1. Remove obstruction. 2. Replace the spring. 3. Replace the switch.
Hazard Switch Cannot Be Turned Off	Foreign material between hazard support cancelling leg and yoke.	Remove the foreign material. • No foreign material. Replace the turn signal switch.
Hazard Switch Will Not Stay On Or Difficult To Turn Off	1. Loose switch, mounting screws. 2. Interference with other components. 3. Foreign material. 4. None of the above.	1. Tighten mounting screws. 2. Remove the interference. 3. Remove the foreign material. 4. Replace the switch.

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IGNITION LOCK SYSTEM

Refer to "Diagnosis of the Steering Column."

ON-VEHICLE SERVICE

WIRING REPAIRS

For wiring repairs and electrical diagnosis, refer to the Driveability, Emissions and Electrical Diagnosis Manual.

NOTICE: Do not repair or splice the wire harness on the column side of the connector. If wiring within the column requires repair, replace the component with a new replacement part. Failure to follow these instructions could cause a short circuit and malfunction of the steering column controls.

SHIFT INDICATOR ADJUSTMENT (COLUMN SHIFT)



Adjust (Figure 1)

1. Position the shift lever in "N" (Neutral) notch.
2. Move pointer clip (10) on edge of shift bowl (11) to centrally position pointer on "N" (Neutral).
 - Make sure the cable (9) rests on shift bowl and not on column jacket.
3. Push the clip (10) fully seated onto the bowl (11).
4. Make sure the clip is tight on the bowl and does not slip.
5. Move the shift lever through all positions and then back to "N" to check adjustment. Make sure the pointer covers a portion of each graphic, or the flag fills the entire window for each graphic of the shift indicator (8).

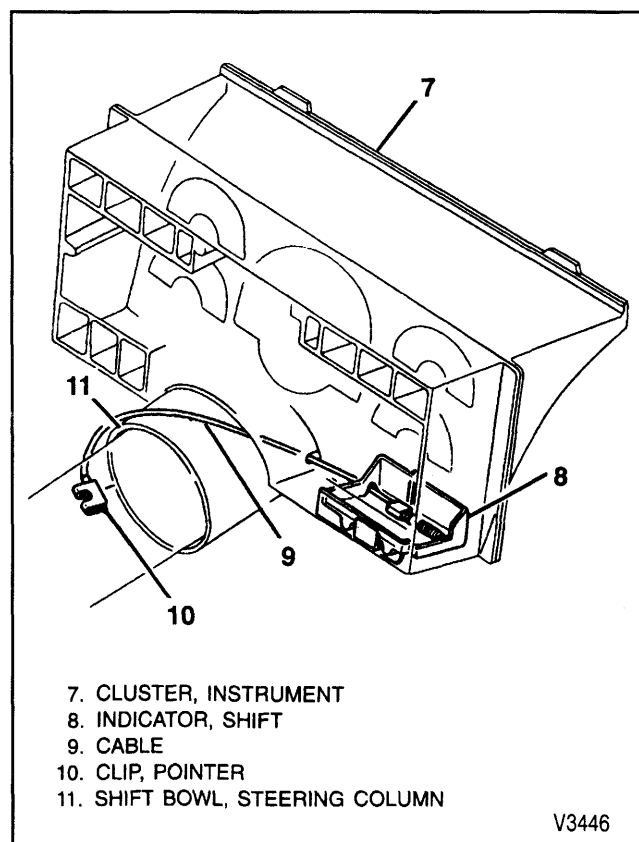


Figure 1—Shift Indicator Adjustment

3F-6 STEERING WHEEL AND COLUMN ON-VEHICLE SERVICE

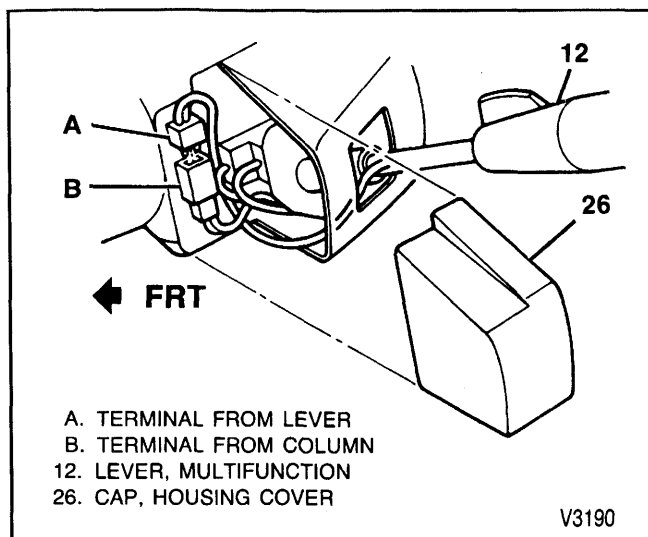


Figure 2—Multifunction Lever

IGNITION SWITCH

Refer to SECTIONS 3F1 or 3F2.

MULTIFUNCTION TURN SIGNAL LEVER REPLACEMENT

Remove or Disconnect (Figure 2)

1. Make sure the lever is in the center or "Off" position.
2. Unsnap housing cover cap (26) from steering column housing.
3. Cruise control wiring connector (A) from inside of connector (B) installed in column. Refer to SECTION 9B.
4. Pull the lever straight out of the turn signal switch.

Install or Connect (Figure 2)

1. Make sure the lever is in center or "Off" Position.
2. Push the lever into the turn signal switch.
3. Cruise control wiring connectors (A) and (B). Refer to SECTION 9B.
4. Snap housing cover cap (26) to steering column housing.

HAZARD KNOB ASSEMBLY REPLACEMENT

Remove or Disconnect (Figure 3)

1. Screw (28).
2. Button (27).
3. Spring (25).
4. Knob (24).

Install or Connect (Figure 3)

1. Knob (24).
2. Spring (25).
3. Button (27).

NOTICE: Refer to "Notice" on page 3F-1.

4. Screw (28).
 - Fully seated, driven not stripped.

Tighten

- Screw (28) 7 N.m (6 lbs. in.).

SHIFT LEVER REPLACEMENT

Remove or Disconnect (Figure 4)

1. Pivot pin (30) from the bowl assembly.
2. Shift lever (23) from the bowl assembly being careful not to lose spring (31), or insulator (29).
3. Insulator (29) from shift lever (23).
4. Spring (31).

Install or Connect (Figure 4)

- If problems are experienced while installing shift lever over spring, a shim may be used as a guide.

1. Spring (31).
2. Shim over top of spring.
3. Insulator (29).

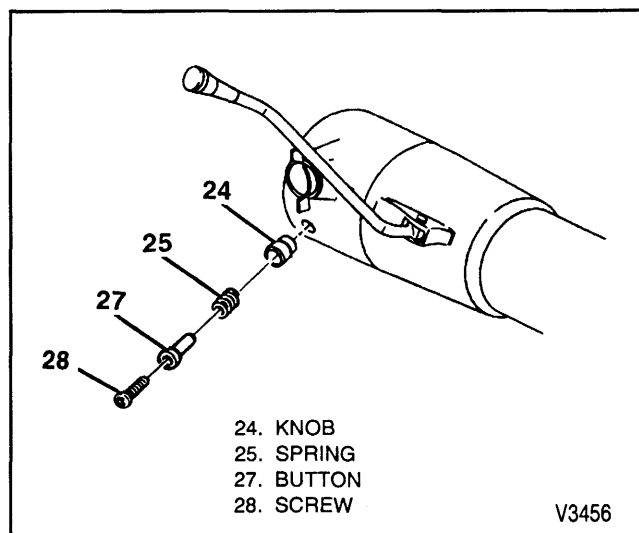


Figure 3—Hazard Warning Knob Assembly

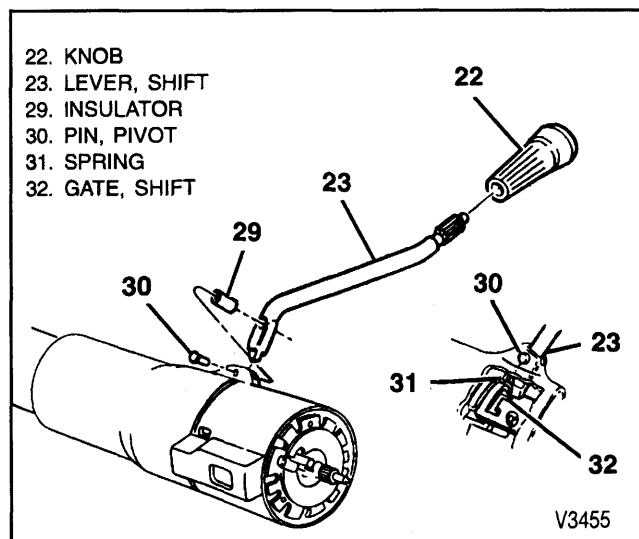


Figure 4—Shift Lever Replacement

4. Shift lever (23).
5. Pivot pin (30).
6. Remove shim.

- After shift lever is installed, check all positions for positive engagement of shift gate.

TILT WHEEL LEVER REPLACEMENT

Remove or Disconnect

1. Twist lever counterclockwise to remove lever.

Install or Connect

1. Twist lever clockwise to install.

HORN SWITCH REPLACEMENT

Remove or Disconnect (Figure 5)

1. Negative battery cable. Refer to SECTION 0A.
2. Pull off horn pad assembly (115).
3. Horn wire assembly (114).

Install or Connect (Figure 5)

1. Horn wire assembly (114).
2. Push on horn pad assembly (115).
3. Negative battery cable.

STEERING WHEEL REPLACEMENT

Remove or Disconnect (Figures 5 and 6)

Tool Required:

J 1859-03 Steering Wheel Puller

1. Horn pad assembly. Refer to "Horn Switch Replacement."
2. Retainer (20).
3. Steering wheel nut (21).

- Not the relationship of alignment mark (A) on the steering wheel and on the steering shaft (figure 5).

4. Steering wheel, using J 1859-03 (figure 6). Do not hammer on the puller, or damage could result to the steering column.

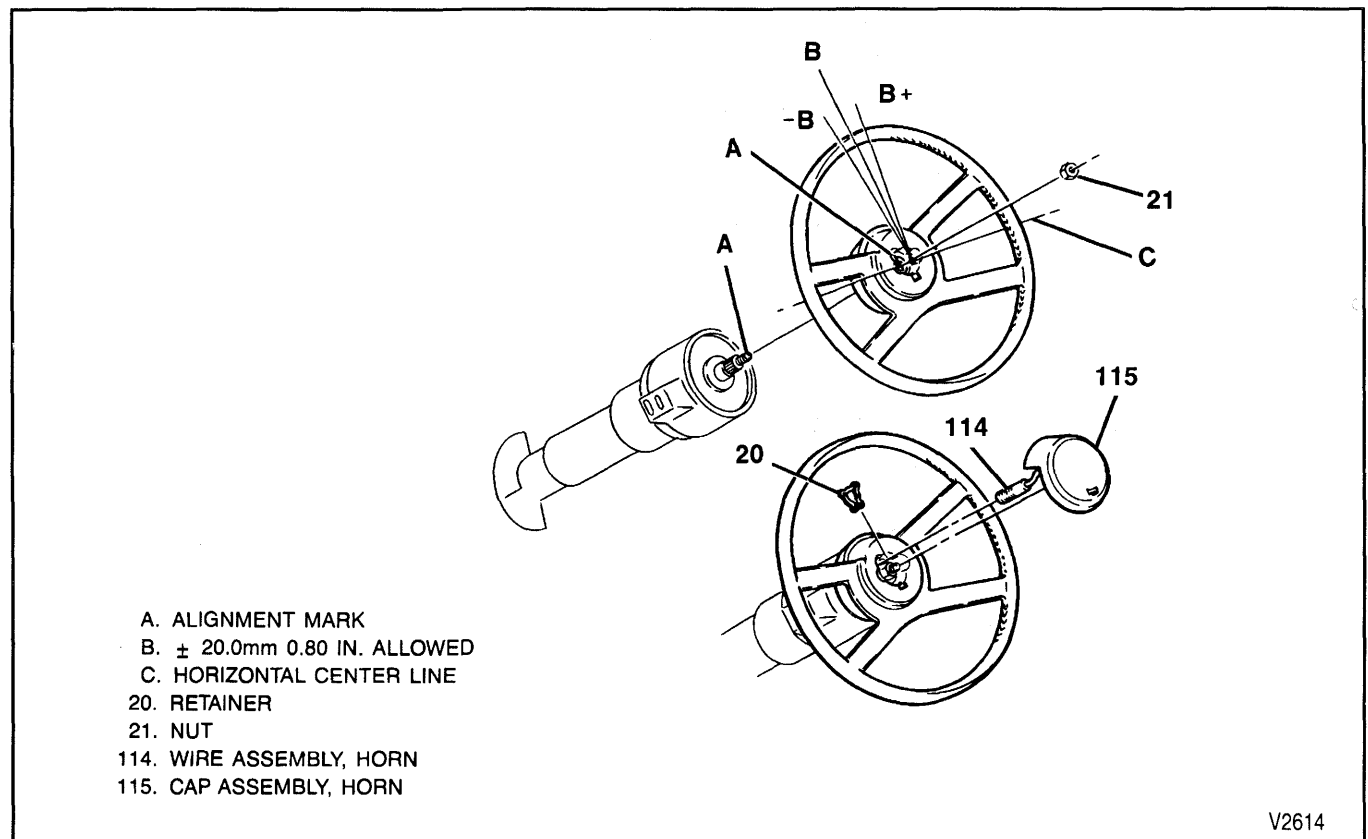
Install or Connect (Figures 5 and 6)

- The turn signal control assembly must be in the neutral position when assembling the steering wheel.

1. Steering wheel onto the steering shaft. Align the marks (A) on steering shaft and steering wheel.

Important

- Do not misalign the steering wheel more than 20 mm (0.80 inch) from the horizontal centerline (figure 5).



V2614

Figure 5—Steering Wheel Assembly

INTERMEDIATE SHAFT REPLACEMENT

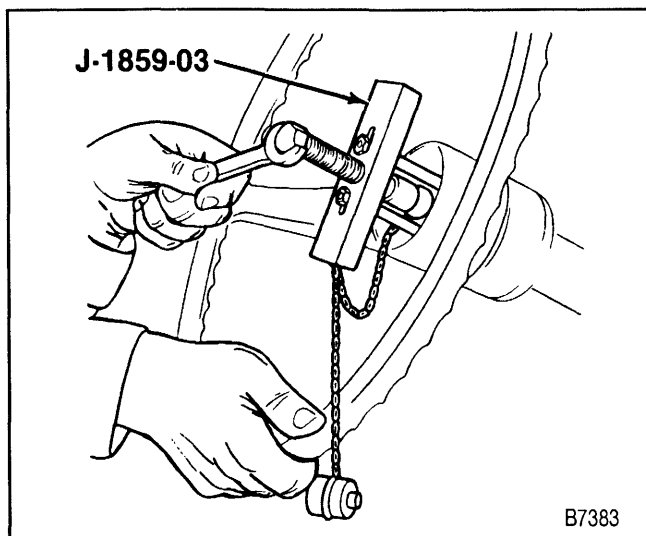


Figure 6—Steering Wheel Removal

2. Horn lead assembly.

NOTICE: Refer to "Notice" on page 3F-1.

3. Steering wheel nut (21).



Tighten

• Nut to 40 N·m (30 lbs. ft.).

4. Retainer (20).

5. Horn pad assembly. Refer to "Horn Switch Replacement."



Remove or Disconnect (Figure 7)

- Set the front wheels in the straight-ahead position and the steering wheel in the "LOCKED" position.
- Mark the intermediate shaft pot joint yoke to steering shaft and the rag joint yoke to the steering gear inputshaft relationship to be sure of proper installation.

1. Shield (19) from intermediate shaft (12).
2. Nut (17) and bolt (16) from upper pot joint.
3. Bolt (15) from lower rag joint.
4. Intermediate shaft assembly (12) by sliding shaft up (towards dash) to get rag joint yoke to clear steering gear inputshaft.
5. Slide intermediate shaft (12) down off the upper steering column shaft (18). This may require the use of a small hammer tapping on the yoke to free it from the shaft.



Install or Connect (Figure 7)

NOTICE: For steps 3 and 4, refer to "Notice" on page 3F-1.

1. Upper end of intermediate shaft (12) onto upper steering column shaft (18).
2. Lower end of intermediate shaft (12) onto steering gear wormshaft. Align marks made at removal.

12. SHAFT, INTERMEDIATE
13. GEAR, STEERING
14. COUPLING
15. BOLT, PINCH 30 N·m (22 FT. LBS.)
16. BOLT, PINCH
17. NUT, 64 N·m (47 FT. LBS.)
18. COLUMN, STEERING
19. SHIELD

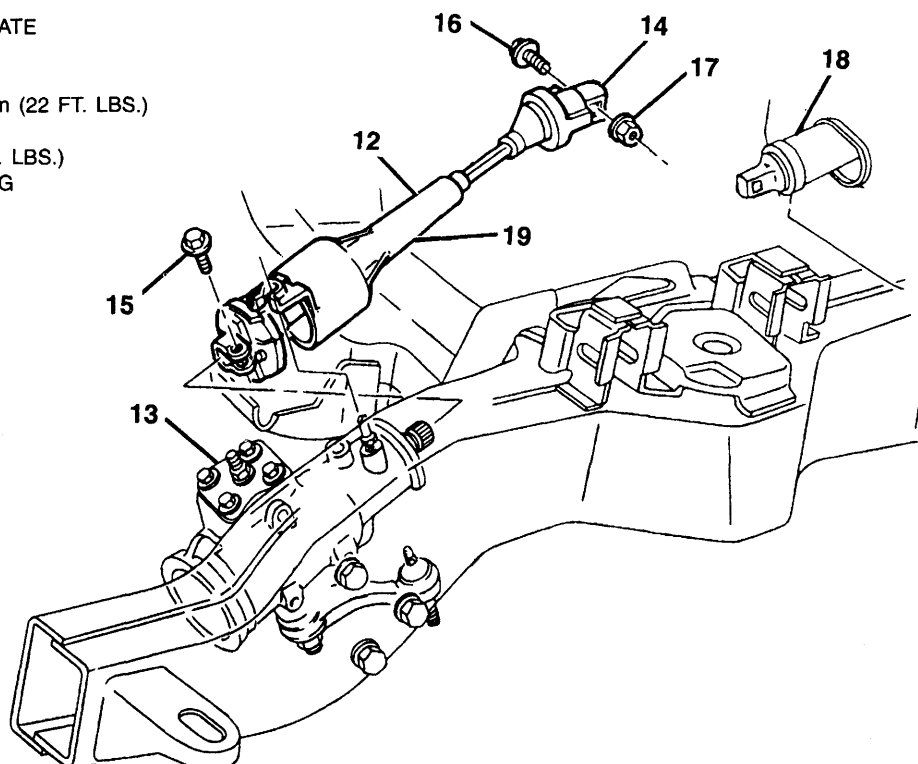


Figure 7—Intermediate Shaft installation

3. Bolt (15) to lower rag joint.
4. Bolt (16) and nut (17) to upper pot joint.



Tighten

- Nut (17) and bolt (16) to 64 N.m (47 lbs. ft.).
 - Pinch bolt (15) to 30 N.m (22 lbs. ft.).
5. Shield (19) over intermediate shaft (12).

STEERING COLUMN REPLACEMENT



Remove or Disconnect (Figures 7 and 8)

1. Negative battery cable. Refer to SECTION 0A.
2. Steering wheel. Refer to "Steering Wheel Replacement."
3. Transmission control linkage from the column shift tube levers.
4. Pot joint nut (17) and bolt (16) from the steering shaft. Mark the relationship of the pot joint to the steering shaft.

5. Steering column filler panel. Refer to SECTION 10A4.
6. Bolts (5), nuts (4), and bracket (2).
7. Screws (6) and seal (3).
8. Steering column harness at the connectors.

- Disconnect the neutral-start switch and backup lamp switch connectors (some models).

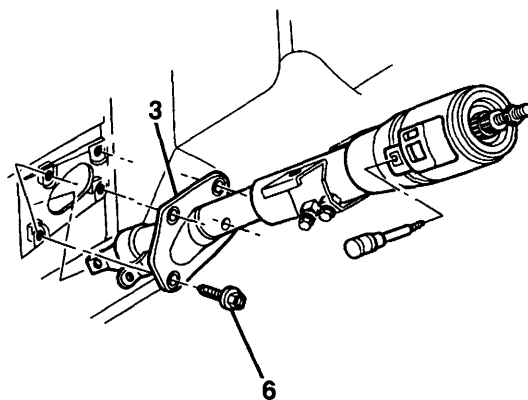
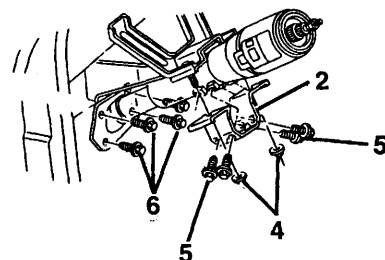
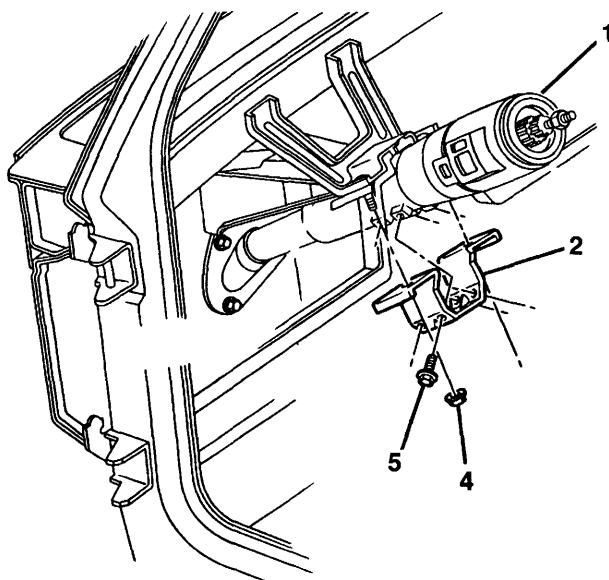
9. Steering column assembly. Rotate the column so the shift lever clears the dash opening.



Install or Connect (Figures 7 and 8)

1. Lower the end of the steering column through the dash opening.
2. Connectors to the steering column harness.
 - Connect the neutral-start switch and backup lamp switch connectors (some models).
3. Bracket (2), bolts (5), and nuts (4) loosely. Tighten bolts and nuts finger tight.

NOTICE: Refer to "Notice" on page 3F1-1.



1. COLUMN, STEERING
2. BRACKET, SUPPORT
3. SEAL
4. NUTS
5. BOLTS
6. SCREWS

V2851

Figure 8—Steering Column Installation

3F-10 STEERING WHEEL AND COLUMN ON-VEHICLE SERVICE

4. Screws (6) through the cover and seal to the dash panel.



Tighten

- Screws (6) to 12 N.m (105 lbs. in.).
- Bolts (5) to 30 N.m (22 lbs. ft.).
- Nuts (4) to 27 N.m (20 lbs. ft.).

5. Steering column filler panel. Refer to SECTION 10A4.

6. Intermediate shaft pot joint to steering column lower shaft end. Refer to "Intermediate Shaft Replacement."

7. Transmission control linkage.

8. Steering wheel. Refer to "Steering Wheel Replacement."

9. Negative battery cable.

CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

Refer to SECTIONS 3F1 or 3F2.

SPECIFICATIONS

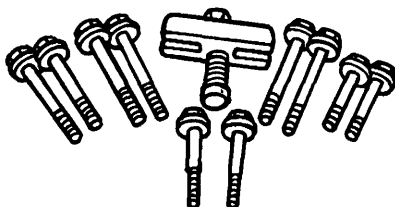
FASTENER TIGHTENING SPECIFICATIONS

Item	N-m	Ft. Lbs.	In. Lbs.
Hazard Warning Knob Screw.....	7	—	6
Intermediate Shaft Pinch Bolt (15)	30	22	—
Intermediate Shaft Pinch Bolt Nut (17)	64	47	—
Lower Brace Screws (6).....	12	—	105
Steering Column Bracket Nuts (4).....	27	20	—
Steering Wheel Nut (21)	40	30	—
Support Bracket Bolts (5).....	30	22	—

T2969

SPECIAL TOOLS

1.



J 1859-A

1. STEERING WHEEL PULLER

V3305

SECTION 3F1A

STANDARD STEERING COLUMN COLUMN SHIFT UNIT REPAIR

CAUTION: Before removing any electrical units, disconnect the negative battery cable to help prevent personal injuries and/or damage to vehicle components.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Buzzer Switch Assembly		Adapter & Bearing Assembly	
Steering Col Lock Cylinder Set		Gearshift Lever Bowl Assembly	
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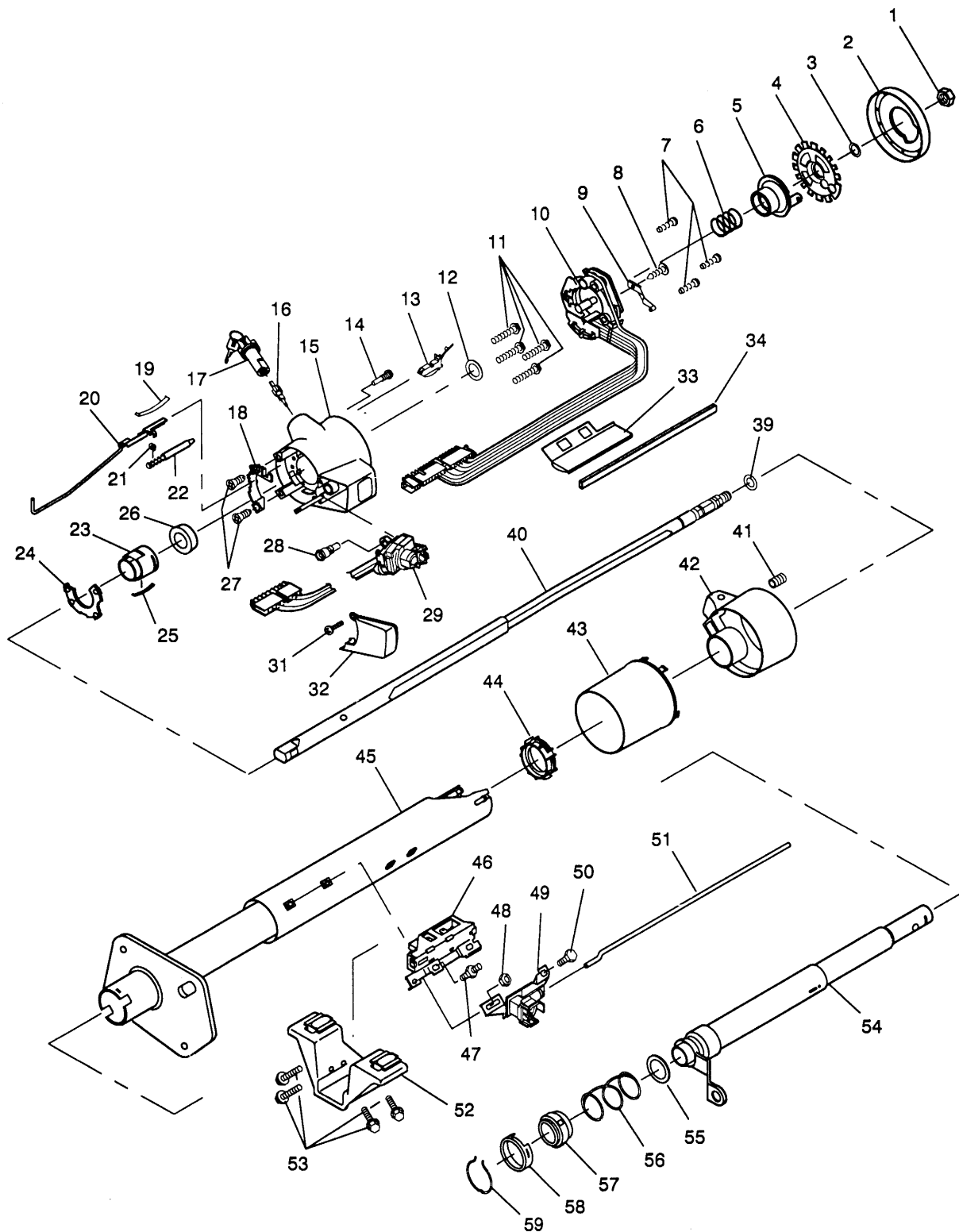


Figure 1 - Standard Steering Column

1-NUT, HEXAGON JAM (M14x1.5)
 2-COVER, SHAFT LOCK
 3-RING, RETAINING
 4-LOCK, STEERING SHAFT
 5-CAM ASM, TURN SIG CANCELLING
 6-SPRING, UPPER BEARING
 7-SCREW, BIND HD CROSS RECESS
 8-SCREW, RD WASH HD (M4.2x1.41)
 9-ARM, SWITCH ACTUATOR
 10-SWITCH ASM, TURN SIGNAL
 11-SCREW, HEX WASHER HD TAPPING
 12-WASHER, THRUST
 13-SWITCH ASM, BUZZER
 14-SCREW, LOCK RETAINING
 15-HOUSING ASM, STEERING COLUMN
 16-SECTOR, SWITCH ACTUATOR
 17-LOCK CYLINDER SET, STRG COLUMN
 18-GATE, SHIFT LEVER
 19-SPRING, RACK PRELOAD
 20-ACTUATOR ASM, IGNITION SWITCH
 21-WASHER, SPRING THRUST
 22-BOLT ASSEMBLY, SPRING &
 23-BUSHING, BEARING RETAINING
 24-RETAINER, UPPER BEARING
 25-CONTACT, HORN CIRCUIT
 26-BEARING ASM
 27-SCREW, FLT HD CROSS RECESS
 28-PIN, SWITCH ACTUATOR PIVOT
 29-SWITCH ASM, PIVOT & (PULSE)
 31-SCREW, BINDING HD CROSS RECESS
 32-COVER, HOUSING
 33-PROTECTOR, WIRING
 34-PROTECTOR, WIRING
 39-RING, RETAINING
 40-SHAFT ASM, STEERING
 41-SPRING, SHIFT LEVER
 42-BOWL ASM, GEARSHIFT LEVER
 43-SHROUD, GEARSHIFT BOWL
 44-BEARING, BOWL LOWER
 45-JACKET ASM, STRG COL
 46-SWITCH ASM, IGNITION
 47-STUD, DIM & IGN SW MTG
 48-NUT, HEXAGON (#10-24)
 49-SWITCH ASM, DIMMER
 50-SCREW, WASHER HD (#10-24 x .25)
 51-ROD, DIMMER SWITCH ACTUATOR
 52-BRACKET ASM, STRG COL SUPT
 53-BOLT, FLGD HEX HD (M8X1.25)
 54-TUBE ASM, SHIFT
 55-WASHER, SPRING THRUST
 56-SPRING, SHIFT TUBE RETURN
 57-BEARING ASM, ADAPTER &
 58-RETAINER, BEARING
 59-CLIP, LOWER BEARING ADAPTER

Service Kits

201-HSG ASM SERV SET, STRG COL
 -INCLUDES: 16,17,23,24,26
 202-RACK SERV ASM, SW ACTR ROD &
 -INCLUDES: 20
 203-SECTOR SERV KIT, IGN SW ACTR
 -INCLUDES: 16
 204-GREASE SERV KIT, (SYNTHETIC)

Figure 2 - Standard Steering Column - Legend

SUB SECTION A - UPPER COLUMN

Figures 1 through 6

INCLUDES:

**STEERING SHAFT LOCK
TURN SIGNAL CANCELLING CAM ASM
UPPER BEARING SPRING
THRUST WASHER
TURN SIGNAL SWITCH ASSEMBLY
BUZZER SWITCH ASSEMBLY
STRG COLUMN LOCK CYLINDER SET**

Tools Required:

J 23653-C Lock Plate Compressor

! Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

↔ Remove or Disconnect

- Negative (-) battery cable.
- Shaft lock cover (2).
- Shaft lock retaining ring (3) using J 23653-C to push down steering shaft lock (4).
 - Dispose of ring (3).
- Shaft lock (4) from steering shaft assembly (40).

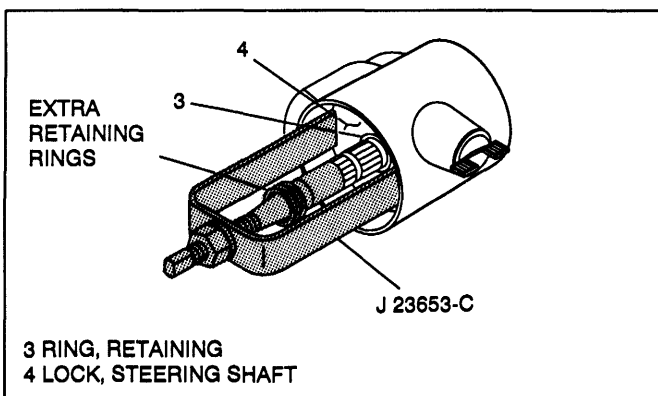


Figure 3 - Removing Shaft Lock Retaining Ring

- Turn signal cancelling cam assembly (5).
- Upper bearing spring (6).
- Thrust washer (12).
- Turn signal to "RIGHT TURN" position (up).

- Multi-function lever and hazard knob assembly. (See Section 3F)
- Washer head screw (8) and switch actuator arm (9).
- Three cross recess screws (7).
- Turn signal switch assembly (10).
 - Let switch hang freely.
 - To remove switch (10):
 - Hex head bolts (53).
 - Steering column support bracket assembly (52).
 - Turn signal switch connector from vehicle wire harness.
 - Wiring protectors (33) and (34).
 - Gently pull wire harness through column.
- Key from steering column lock cylinder set (17).
- Buzzer switch assembly (13).
- Insert key in lock cylinder (17).
 - Key in "lock" position.
- Lock retaining screw (14).
- Steering column lock cylinder set (17).

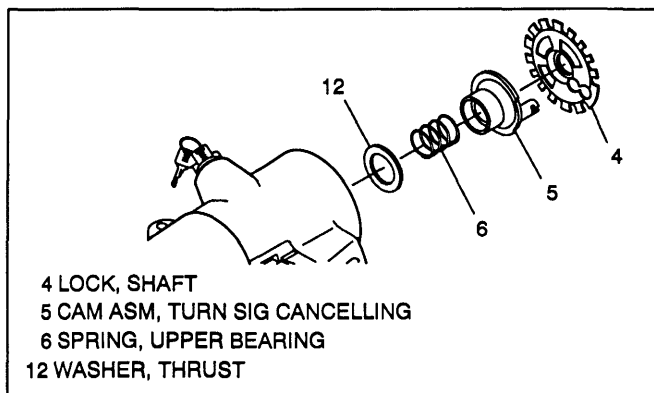


Figure 4 - Removing Components from Upper Shaft

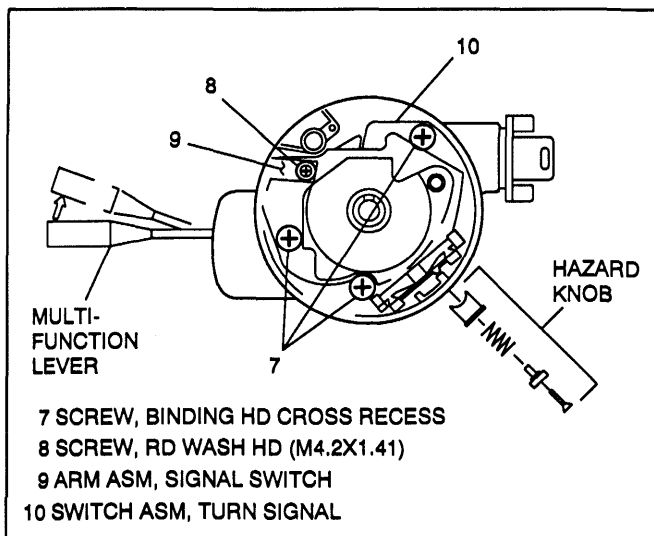


Figure 5 - Turn Signal Switch Removal Preparation

 Install or Connect

NOTICE: See "Notice" on page 3F1A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Steering column lock cylinder set (17).
2. Lock retaining screw (14).

 Tighten

- Tighten screw (14) to 4.5 N·m (40 lb.in.)
3. Key from lock cylinder set (17).
 4. Buzzer switch assembly (13).
 5. Reinsert key in lock cylinder set (17).
 - Key in "lock" position.
 6. Turn signal switch assembly (10) wire harness through steering column.
 - A. Let switch hang freely.
 - B. Switch connector to vehicle wire harness.
 - C. Wiring protectors (33) and (34).
 - D. Support bracket (52).
 - E. Hex head bolts (53).

 Tighten

- Tighten bolts (53) to 30.0 N·m (22 lb.ft.).

7. Turn signal switch (10) and three screws (7).

 Tighten

- Tighten screws (7) to 3.4 N·m (30 lb.in.).

8. Switch actuator arm (9) and screw (8).

 Tighten

- Tighten screw (8) to 2.3 N·m (20 lb.in.).

9. Hazard knob assembly and multi-function lever. (See Section 3F)
10. Thrust washer (12).
11. Upper bearing spring (6).
12. Turn signal cancelling cam assembly (5).
 - Lubricate with grease, synthetic (service kit).

13. Shaft lock (4).
14. New shaft lock retaining ring (3) using J 23653-C to push down shaft lock (4).
 - Ring (3) must be firmly seated in groove on shaft.

15. Shaft lock cover (2).

NOTICE: Gently pull lower turn signal wires to remove any wire kinks that may be inside steering column assembly. Failure to do so may cause damage to wire harness.

16. Refer to Section 3F to complete remaining steering column assembly.
17. Negative (-) battery cable.

SUB SECTION B - HOUSING COVER**INCLUDES:**

**STEERING SHAFT ASSEMBLY
TURN SIGNAL SWITCH ASSEMBLY
STRG COL HOUSING ASSEMBLY
PIVOT & (PULSE) SWITCH ASM
SPRING & BOLT ASSEMBLY
BEARING ASSEMBLY
SWITCH ACTUATOR SECTOR
IGNITION SWITCH ACTUATOR ASM
DIMMER SWITCH ASSEMBLY
IGNITION SWITCH ASSEMBLY
IGNITION SWITCH ADJUSTMENT
DIMMER SWITCH ADJUSTMENT**

Tools Required:

J 23653-C Lock Plate Compressor

 Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

 Remove or Disconnect
Figures 1, 6 thru 12, 17

1. Negative (-) battery cable.
2. Steering column from vehicle. (See Section 3F)

3F1A-6 STD STRG COL UNIT REPAIR (COL SHFT)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage. (See Figure 17)

- Do all steps, "Remove or Disconnect", Sub Section A.
- Steering shaft assembly (40).
 - Retaining ring (39) from shaft (40).
 - Dispose of ring (39).

Inspect

- Steering column shaft assembly (40) for accident damage. (See Figure 17)

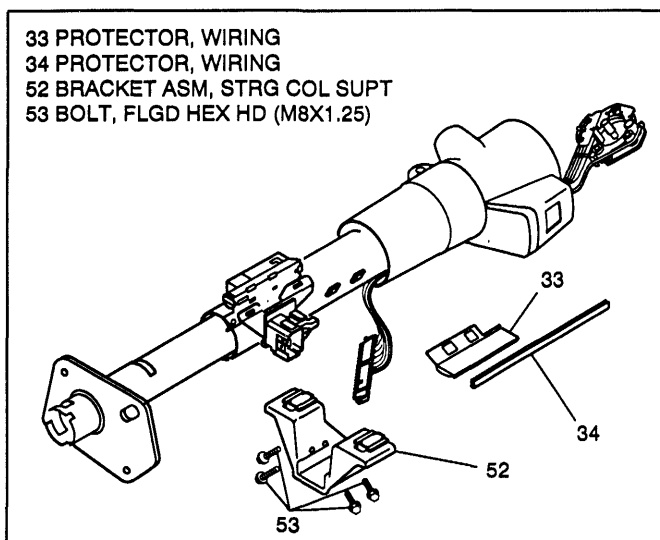


Figure 6 - Removing Turn Signal Switch

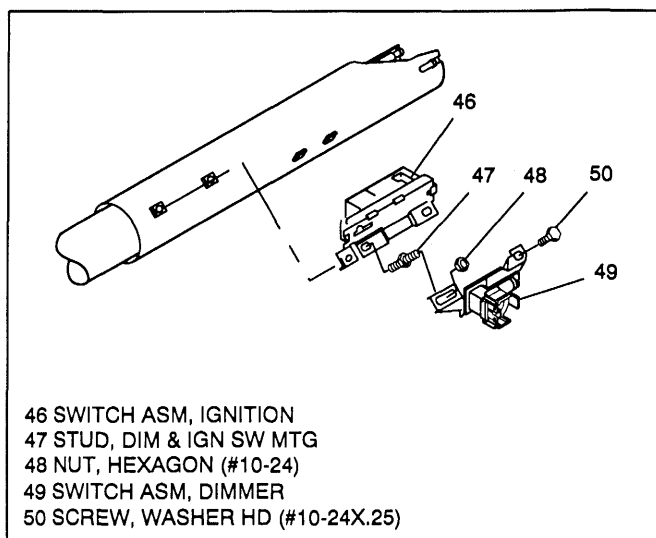


Figure 7 - Removing Dimmer & Ignition Switch Asm

- Four hex bolts (53).
- Steering column support bracket assembly (52).
- Wiring protectors (33) and (34).
- Turn signal switch assembly (10).
- Washer head screw (50).
- Hexagon nut (48).
- Dimmer switch assembly (49).
- Dimmer switch actuator rod (51).
- Dimmer & ignition switch mounting stud (47).
- Ignition switch assembly (46).
- Four hex washer head tapping screws (11).

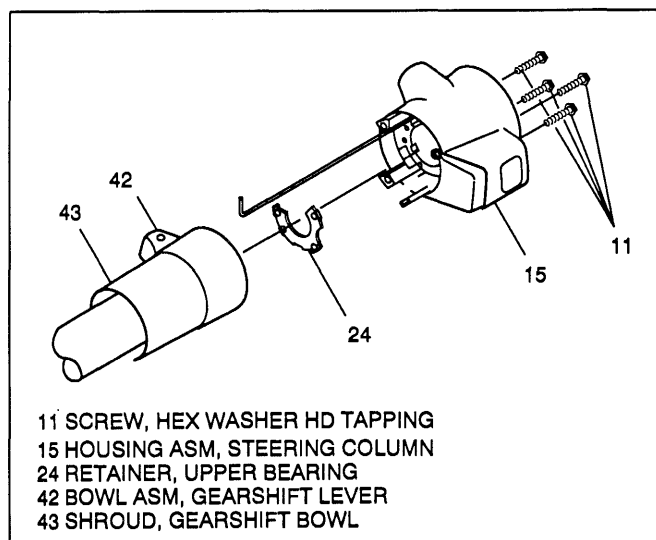


Figure 8 - Removing Steering Column Housing Assembly

16. Steering column housing assembly (15) from gearshift lever bowl assembly (42) and gearshift bowl shroud (43).

- Upper bearing retainer (24).

! Important

- Remove only those components necessary to do repairs.

Disassemble

Steering Column Housing Assembly

- A. Two flat head cross recess screws (27).
B. Shift lever gate (18).

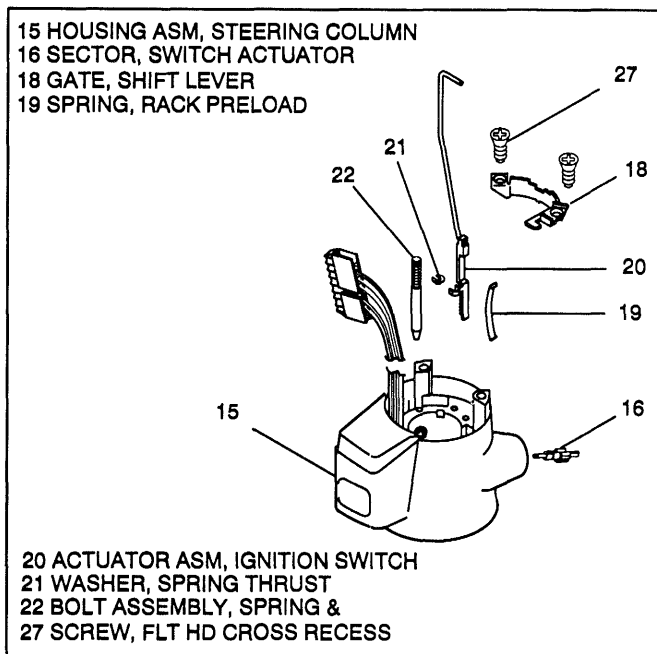


Figure 9 - Removing Switch Actuator Assembly With Spring & Bolt Assembly

- C. Ignition switch actuator assembly (20) with spring & bolt assembly (22).
- Spring & bolt assembly (22) from switch actuator rack (20).
 - Spring thrust washer (21) from spring & bolt assembly (22).

- D. Switch actuator sector (16).
E. Rack preload spring (19).
F. Binding head cross recess screw (31).
G. Housing cover (32).
H. Switch actuator pivot pin (28).
• Pivot & (pulse) switch assembly (29).
I. Bearing retaining bushing (23).
• Horn circuit contact (25).
J. Bearing assembly (26).

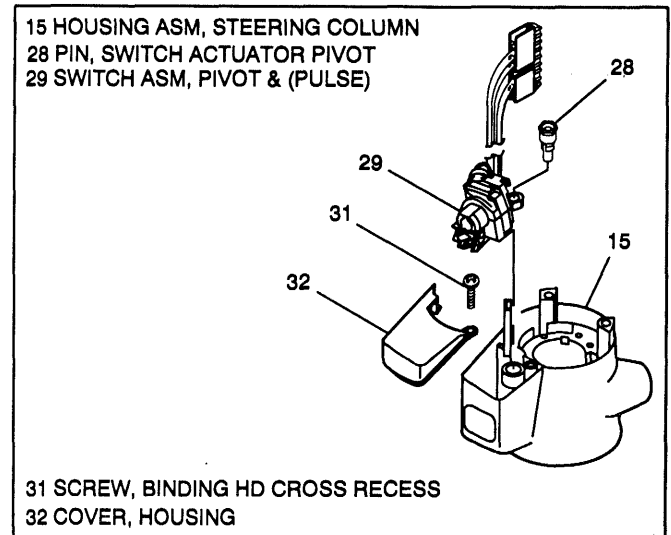


Figure 10 - Removing Pivot & (pulse) Switch Assembly

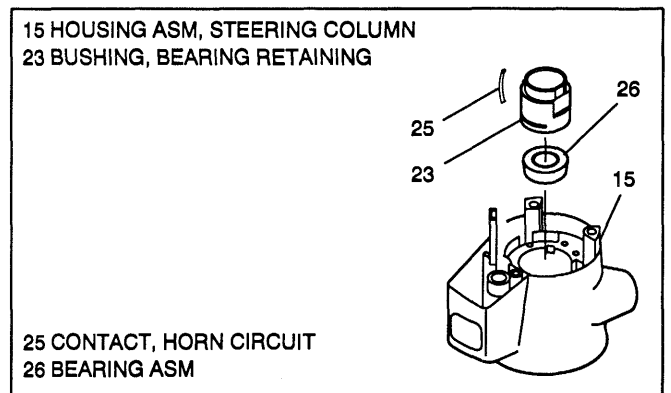


Figure 11 - Removing Bearing Retaining Bushing and Bearing Assembly

Assemble

Steering Column Housing Assembly

- A. Bearing assembly (26).
B. Horn circuit contact (25) to retaining bushing (23).
C. Bearing retaining bushing (23).

- D. Pivot & (pulse) switch assembly (29) with switch actuator pivot pin (28).

Tighten

- Tighten pin (28) to 3.1 N·m (27 lb.in.).

- E. Housing cover (32).
F. Cross recess screw (31).

Tighten

- Tighten screw (31) to 1.9 N·m (17 lb.in.).
- G. Rack preload spring (19).
H. Switch actuator sector (16).
I. Spring thrust washer (21) to spring & bolt assembly (22).
J. Spring & bolt assembly (22) to switch actuator rack (20).
K. Switch actuator rack (20) and bolt assembly (22) to housing assembly (15).
L. Shift lever gate (18).
M. Two cross recess screws (27).

Tighten

- Tighten screws (27) to 5.1 N·m (45 lb.in.).

Important

First tooth of actuator rack (20) must interact with first and second tooth of sector (16). With actuator rack (20) fully inserted, block tooth of sector (16) will rest in block tooth of rack (20).

Install or Connect *Figures 1, 13 and 14*

NOTICE: See "Notice" on page 3F1A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. New retaining ring (39) to shaft assembly (40).
2. Shaft assembly (40) to jacket assembly (45).
 - Lubricate with lithium grease.
3. Turn signal switch (10) connector through column housing assembly (15).
4. Upper bearing retainer (24).
5. Lock housing cover assembly (15).
6. Cover screws (11).
 - Tighten screws (11) in a clockwise order finger tight.

Tighten

- Tighten screws (11) in same order to 5.3 N·m (47 lb.in.).

7. Wiring protectors (33) and (34).
8. Support bracket (52).
9. Hex head bolt (53).

Tighten

- Tighten bolt (53) to 30.0 N·m (22 lb.ft.).

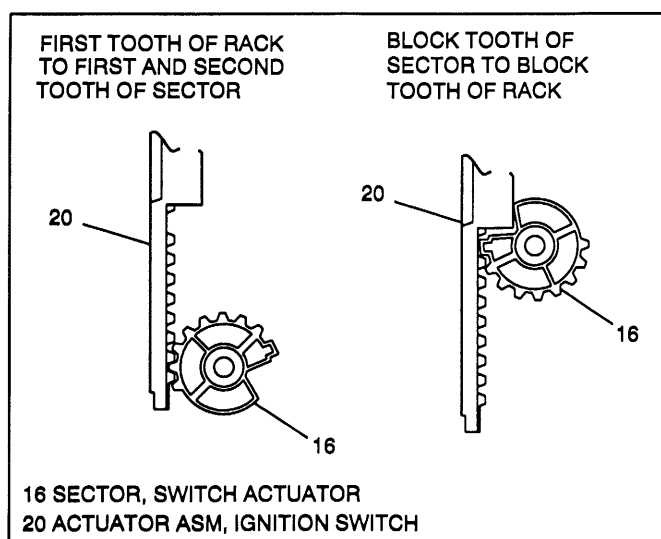


Figure 12 - Installing Switch Actuator Rack to Sector

NOTICE: Install ignition switch (46) to jacket (45) with switch in "OFF-LOCK" position. (See Figure 13) New ignition switch will be pinned in "OFF-LOCK" position. Remove plastic pin after switch is assembled to column. Failure to do so may cause switch damage.

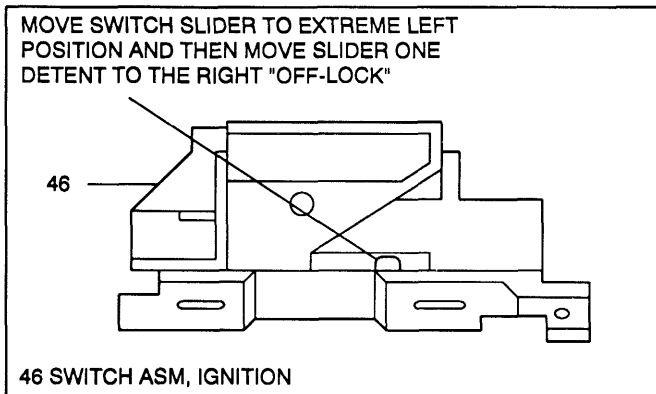


Figure 13 - Adjusting Ignition Switch

Adjust

- Ignition switch assembly (46). (See Figure 13)
 - A. Move switch slider to extreme left position.
 - B. Move switch slider one detent to right "OFF-LOCK" position.

10. Ignition switch assembly (46) and dimmer & ignition switch mounting stud (47).

Tighten

- Tighten screw (47) to 4.0 N·m (35 lb.in.).
11. Dimmer switch rod (51).
 12. Dimmer switch assembly (49) to rod (51).
 13. Washer head screw (50) and hexagon nut (48).
 - Tighten finger tight.

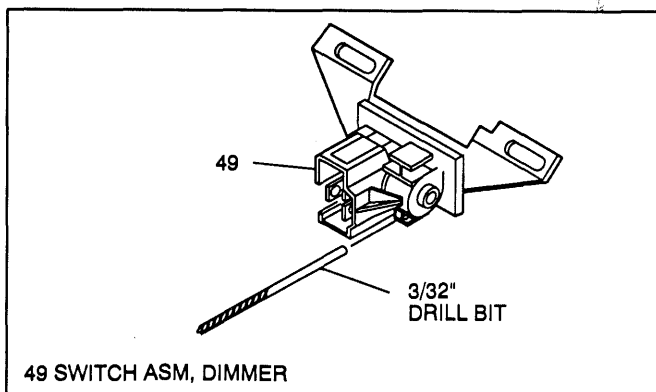


Figure 14 - Adjusting Dimmer Switch

Adjust

- Dimmer switch (49). (See Figure 14)
 - A. Place a 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod to remove all lash.
 - C. Remove drill bit.

Tighten

- Tighten nut (48) and screw (50) to 4.0 N·m (35 lb.in.).

14. Do all steps, "Install or Connect", Sub Section A.
15. Column to vehicle instrument panel. (See Section 3F to complete remaining steering column assembly)
16. Negative (-) battery cable.

SUB SECTION C

Figures 1, 15 through 17

INCLUDES:

**ADAPTER & BEARING ASSEMBLY
GEARSHIFT LEVER BOWL ASM
SHIFT TUBE ASSEMBLY
BOWL LOWER BEARING**

Tools Required:

J 23653-A Lock Plate Compressor

Important

- Before doing any service procedures in this section, removal Steering Wheel is needed. (Refer to service procedures in Section 3F)

↔ Remove or Disconnect

NOTICE: If vehicle has been in an accident, remove column from vehicle and inspect for damage. (See Figure 17)

1. Do steps 1 thru 12, "Remove or Disconnect", Sub Section B.

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

2. Lower bearing adapter clip (59).
3. Bearing adapter retainer (58).
4. Adapter & bearing assembly (57).
5. Shift tube return spring (56).
6. Spring thrust washer (55).
7. Gearshift lever bowl assembly (42) and gearshift bowl shroud (43).
 - Shroud (43) from bowl (42).
 - Shift lever spring (41) from bowl (42).
8. Shift tube assembly (54).
9. Bowl lower bearing (44).

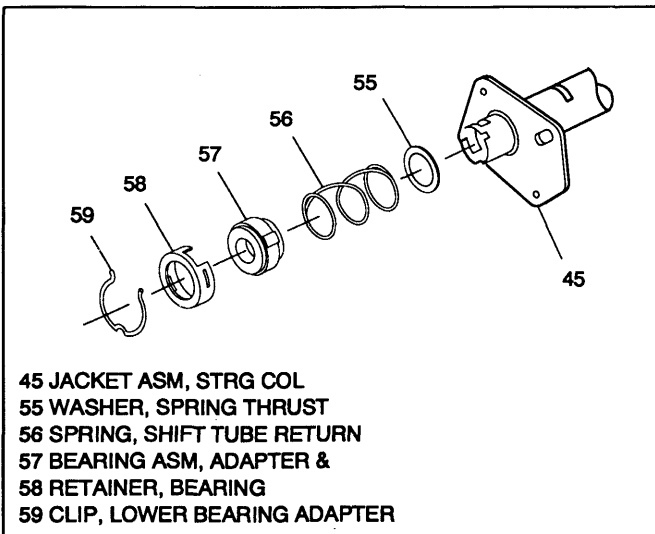


Figure 15 - Removing Lower Bearing Assembly

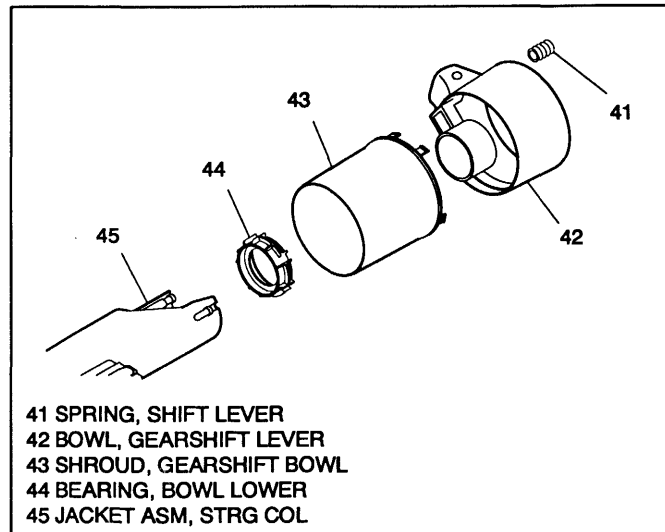


Figure 16 - Removing Lower Bowl Bearing

→← Install or Connect

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Bowl lower bearing (44) to jacket assembly (45).
2. Shift tube assembly (54).
3. Shift lever spring (41) to bowl (42).
4. Gearshift lever bowl (42) and shroud (43) to jacket assembly (45).
5. Spring thrust washer (55).
6. Shift tube return spring (56).
7. Adapter & bearing assembly (57).
8. Bearing adapter retainer (58).
9. Bearing adapter clip (59).
10. Do all steps, "Install or Connect", Sub Section B.

CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

NOTICE: Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, or where the steering column has been impacted may also have a damaged or misaligned steering column.

CHECKING PROCEDURE

JACKET ASM, STEERING COLUMN

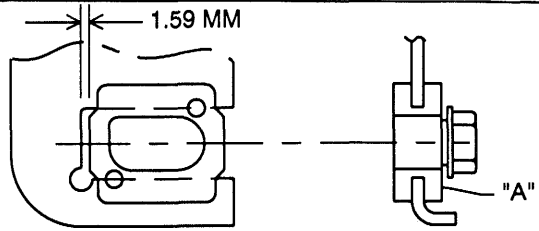
- Check capsules on steering column bracket assembly; all should be within 1.59mm from the bottom of the slots (View A). If not, bracket should be replaced if bracket is bolted to the jacket asm or the jacket asm should be replaced if bracket is welded to jacket asm.
- Check contact surface "A" on capsules (View B). The bolt head must not contact surface "A" or shear load would be increased. If contact is made, replace bracket asm or jacket asm.
- Check for jacket asm collapse by measuring the distance from the lower edge of upper jacket to a defined point on the lower jacket (View E). If measured dimensions are not within specifications, a new jacket must be installed.

SHIFT TUBE ASM

- Visually inspect shift tube for sheared injected plastic (View C). If shift tube shows sheared plastic, a new shift tube must be installed.
- Check operation of shift lever. If you can move lever to "Park" position without raising lever, it is an indication that upper shift tube plastic bearing is broken.

STEERING SHAFT ASM

- Visually inspect steering shaft for sheared injected plastic (View D). If steering shaft shows sheared plastic, a new steering shaft must be installed.
- Any frame damage that could cause a bent steering shaft must have steering shaft runout checked in the following manner: Using a dial indicator at lower end of steering shaft, have steering wheel rotated. Runout must not exceed 1.59mm.



VIEW A

(CAPSULES)

VIEW B

CAPSULES MUST BE WITHIN 1.59 MM FROM BOTTOM OF SLOTS;

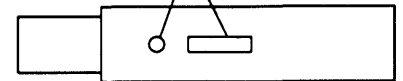
IF NOT, REPLACE BRACKET OR JACKET.

THE BOLT HEAD MUST NOT CONTACT SURFACE "A". IF CONTACT IS MADE, THE CAPSULE SHEAR LOAD WILL BE INCREASED.

REPLACE BRACKET OR JACKET.

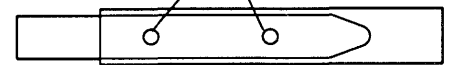
CHECK FOR SHEARED INJECTED PLASTIC AT THESE LOCATIONS.

VIEW C
(SHIFT TUBE)



CHECK FOR SHEARED INJECTED PLASTIC AT THESE LOCATIONS.

VIEW D
(STEERING SHAFT)



269.37 MM
+/-0.25MM

VIEW E

(METHOD TO DETERMINE COLUMN COLLAPSE)
WITH LOWER BEARING REMOVED
MEASURE DISTANCE BETWEEN ARROWS.

Figure 17 - Checking Steering Column for Accident Damage

SPECIFICATIONS

FASTENER TORQUES

1	Steering Wheel-to-Shaft Nut	41.0 N·m (30 lb.ft.)
7	Turn Signal Switch Connecting Screws	3.4 N·m (30 lb.in.)
8	Turn Signal Switch Actuator Assembly Screw	2.3 N·m (20 lb.in.)
11	Lock Housing Cover Screws	5.3 N·m (47 lb.in.)
14	Lock Cylinder Set Retaining Screw	4.5 N·m (40 lb.in.)
27	Shift Lever Gate to Column Housing Screws	5.1 N·m (45 lb.in.)
28	Switch Actuator Pivot Pin	3.1 N·m (27 lb.in.)
31	Housing Cover to Column Housing Screw	1.9 N·m (17 lb.in.)
47	Dimmer & Ignition Switch Mounting Stud	4.0 N·m (35 lb.in.)
48	Lower Dimmer Switch Nut	4.0 N·m (35 lb.in.)
50	Upper Ignition & Dimmer Switch Screw	4.0 N·m (35 lb.in.)
53	Support Bracket Bolts	30.0 N·m (22 lb.ft.)

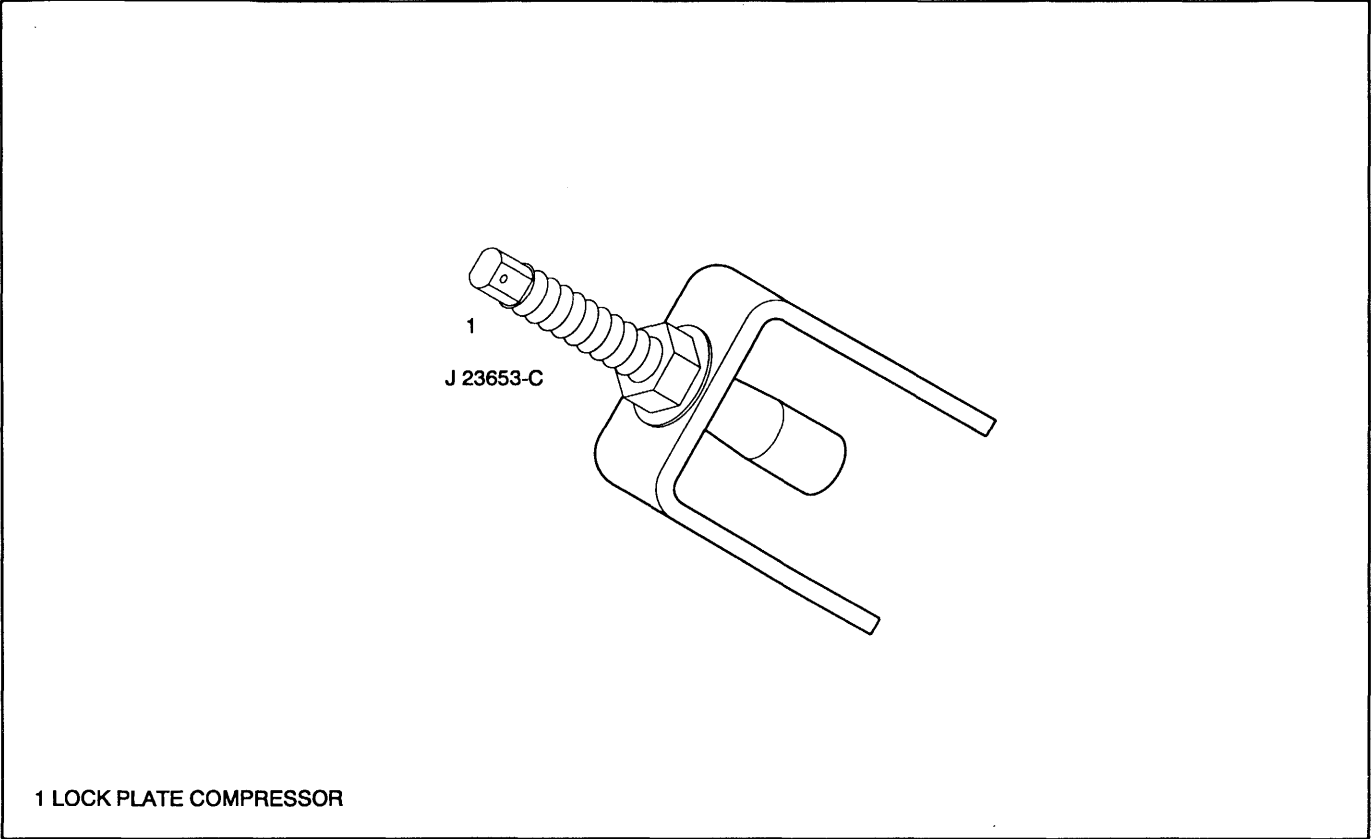


Figure 18 - Special Tools

SECTION 3F1B

STANDARD STEERING COLUMN FLOOR SHIFT UNIT REPAIR

CAUTION: Before removing any electrical units, disconnect the negative battery cable to help prevent personal injuries and/or damage to vehicle components.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

Steering Column, Parts	3F1B-2	Bearing Assembly	
Sub Section A - Upper Column	3F1B-4	Switch Actuator Sector	
Shaft Lock		Ignition Switch Actuator Assembly	
Turn Signal Cancelling Cam Asm		Sub Section C - Lower Column	3F1B-10
Upper Bearing Spring		Dimmer Switch Assembly	
Thrust Washer		Dimmer Switch Adjustment	
Buzzer Switch Assembly		Ignition & Dimmer Switch Asm	
Steering Col Lock Cylinder Set		Ignition Switch Adjustment	
Sub Section B - Housing Cover	3F1B-6	Adapter & Bearing Assembly	
Steering Shaft Assembly		Accident Damage	3F1B-13
Turn Signal Switch Assembly		Specifications	3F1B-13
Steering Col Housing Assembly		Fastener Torques	3F1B-13
Switch Actuator Pivot Assembly		Special Tools	3F1B-14
Spring & Bolt Assembly			

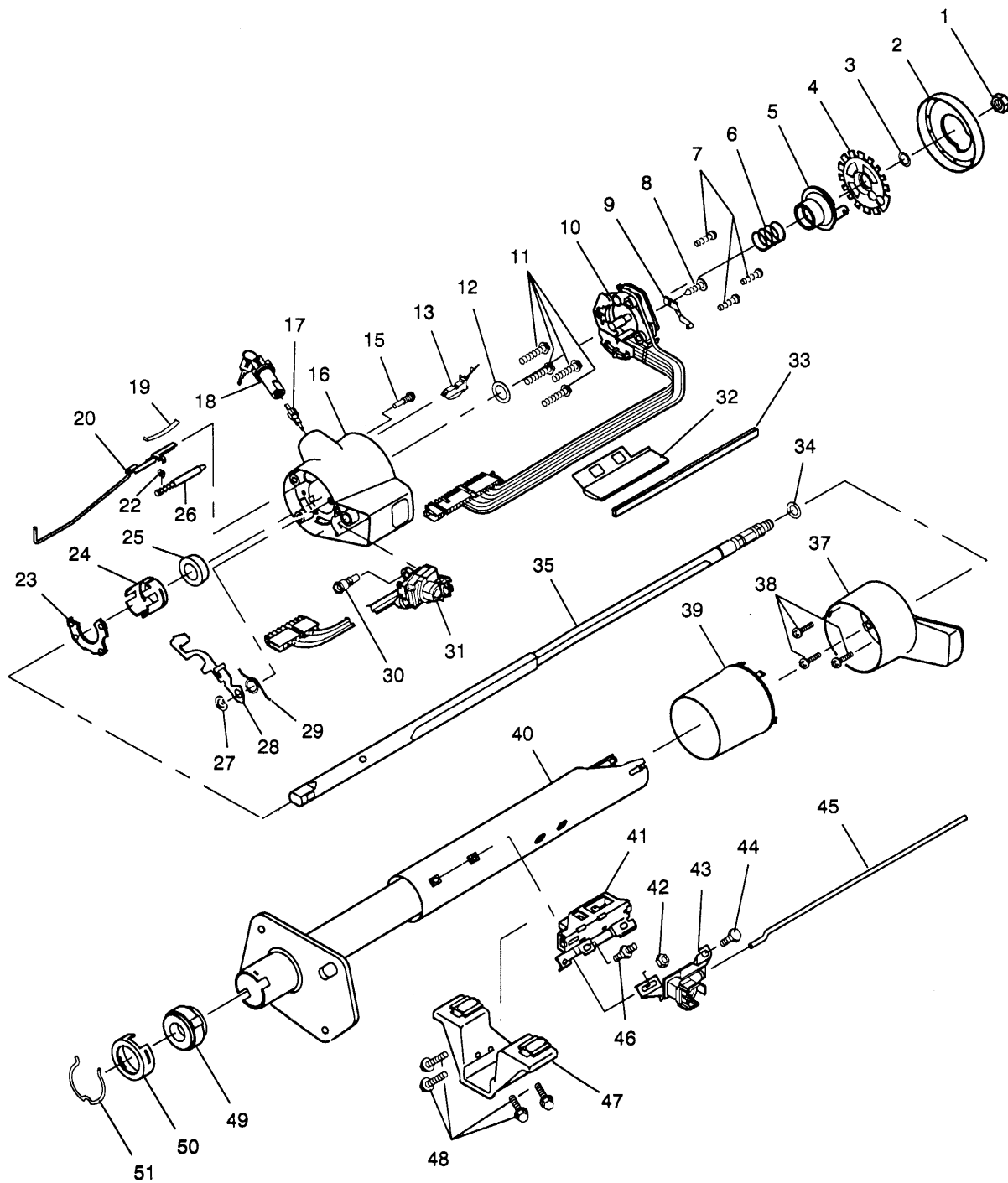


Figure 1 - Standard Steering Column

1-NUT, HEXAGON LOCKING (M14x1.5)
 2-COVER, SHAFT LOCK
 3-RING, RETAINING
 4-LOCK, STEERING SHAFT
 5-CAM ASM, TURN SIG CANCELLING
 6-SPRING, UPPER BEARING
 7-SCREW, BIND HD CROSS RECESS
 8-SCREW, RD WASH HD (M4.2x1.41)
 9-ARM, ACTUATOR SWITCH
 10-SWITCH ASM, TURN SIGNAL
 11-SCREW, HEX WASHER HD TAP
 12-WASHER, THRUST
 13-SWITCH ASM, BUZZER
 15-SCREW, LOCK RETAINING
 16-HOUSING ASM, STRG COL
 17-SECTOR, SWITCH ACTUATOR
 18-LOCK CYLINDER SET, STRG COL
 19-SPRING, RACK PRELOAD
 20-ACTUATOR ASM, IGNITION SWITCH
 22-WASHER, SPRING THRUST
 23-RETAINER, UPPER BEARING
 24-BUSHING, BEARING RETAINING
 25-BEARING ASM
 26-BOLT ASM, SPRING &
 27-WASHER, WAVE
 28-LEVER, KEY RELEASE
 29-SPRING, KEY RELEASE
 30-PIN, SWITCH ACTUATOR PIVOT
 31-SWITCH ASM, PIVOT & (PULSE)
 32-PROTECTOR, WIRING
 33-PROTECTOR, WIRING
 34-RING, RETAINING
 35-SHAFT ASM, STEERING
 37-BOWL, FLOOR SHIFT LEVER
 38-SCREW, BIND HD C/REC
 39-SHROUD, GEARSHIFT BOWL
 40-JACKET ASM, STRG COL
 41-SWITCH ASM, IGNITION
 42-NUT, HEXAGON (#10-24)
 43-SWITCH ASM, DIMMER
 44-SCREW, WASH HD (#10-24 x .25)
 45-ROD, DIMMER SWITCH ACTUATOR
 46-STUD, DIM & IGN SW MTG
 47-BRACKET ASM, STRG COL SUPT
 48-BOLT, FLGD HEX HD (M8X1.25)
 49-BEARING ASM, ADAPTER &
 50-RETAINER, BEARING
 51-CLIP, LOWER BEARING ADAPTER

Service Kits

201-HSG ASM SERV SET, STRG COL
 -INCLUDES: 16,17,23,24,25
 202-GREASE SERV KIT, (SYNTHETIC)
 203-RACK SERV ASM, SW AC ROD &
 -INCLUDES: 20,21
 204-ROD SERVICE KIT, DIMMER SWITCH
 -INCLUDES 45
 205-SECTOR SERV KIT, IGN SW ACTR
 -INCLUDES 17

Figure 2 - Standard Steering Column - Legend

SUB SECTION A - UPPER COLUMN

Figures 1 through 7

INCLUDES:

**SHAFT LOCK
TURN SIGNAL CANCELLING CAM ASM
UPPER BEARING SPRING
THRUST WASHER
BUZZER SWITCH ASSEMBLY
STRG COLUMN LOCK CYLINDER SET**

Tools Required:

J 23653-C Lock Plate Compressor



Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. Refer to service procedures in Section 3F.



Remove or Disconnect

- Negative (-) battery cable.
- Shaft lock cover (2).
- Shaft lock retaining ring (3) using J 23653-C to push down shaft lock (4).
 - Dispose of ring (3).
- Shaft lock (4).

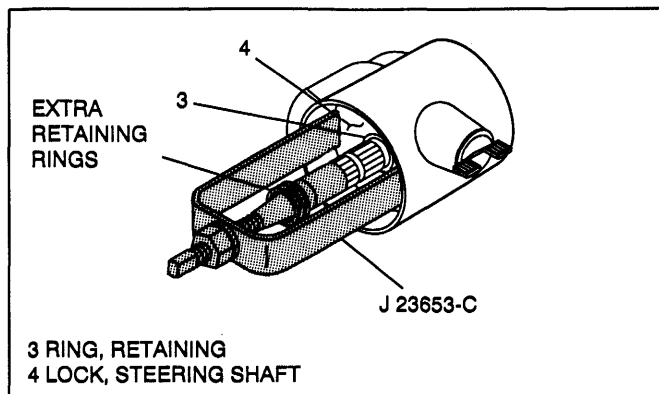


Figure 3 - Removing Shaft Lock Retaining Ring

- Turn signal cancelling cam assembly (5).
- Upper bearing spring (6).
- Thrust washer (12).
- Turn signal to "RIGHT TURN" position (up).
- Multi-function lever and hazard knob assembly. (See Section 3F)
- Screw (8) and signal switch arm (9).
- Turn signal switch screws (7).

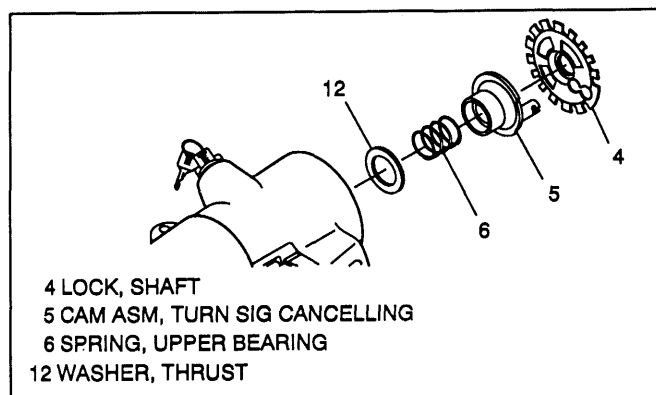


Figure 4 - Removing Components from Upper Shaft

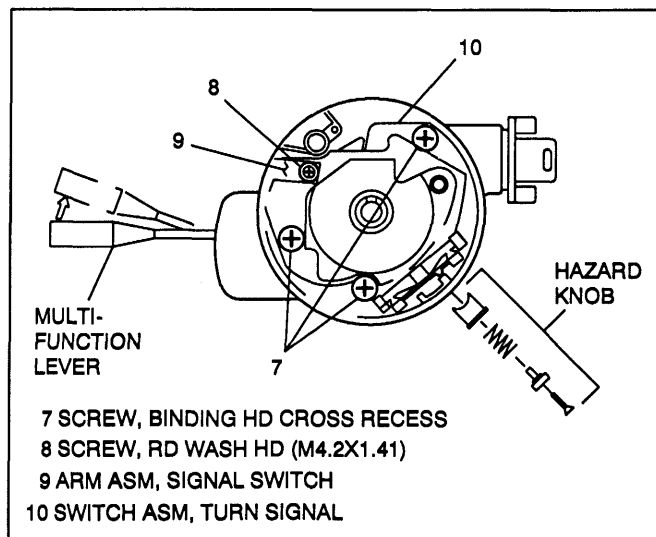


Figure 5 - Turn Signal Switch Removal Preparation

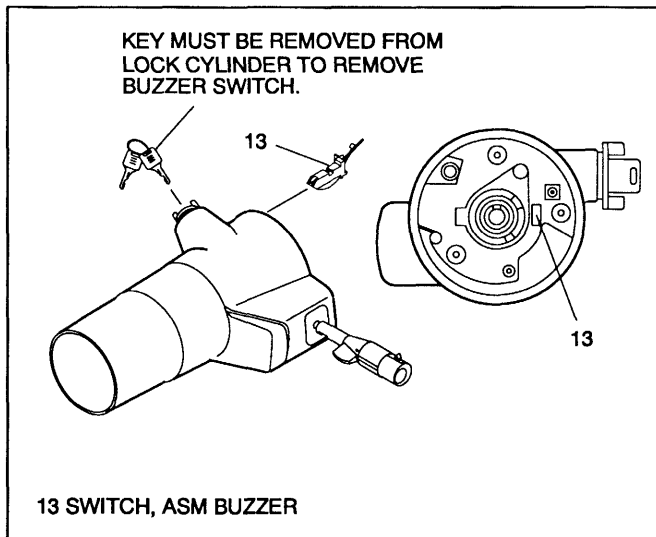


Figure 6 - Removing Buzzer Switch

12. Turn signal switch assembly (10).
 - Let switch hang freely.
 - To remove switch (10):
 - A. Hex head bolts (48).
 - B. Steering column support bracket assembly (47).
 - C. Turn signal switch connector from vehicle wire harness.
 - D. Wiring protectors (32) and (33).
 - E. Gently pull wire harness through column.
13. Key from lock cylinder set (18).
14. Buzzer switch assembly (13).
15. Reinsert key in lock cylinder (18).
 - Key in "LOCK" position.
16. Lock retaining screw (15).
17. Lock cylinder set (18).

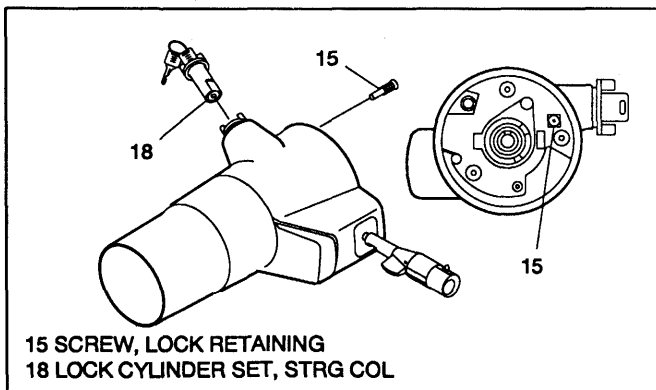


Figure 7 - Removing Lock Cylinder Set

Install or Connect

NOTICE: See "Notice" on page 3F1B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do may result in component damage or malfunctioning of steering column.

1. Lock cylinder set (18).
2. Lock retaining screw (15).

Tighten

- Tighten screw (15) to 4.5 N·m (40 lb.in.).

3. Key from lock cylinder set (18).
4. Buzzer switch assembly (13).
5. Reinsert key in lock cylinder set (18).
 - Key in "LOCK" position.
6. Turn signal switch assembly (10) wire harness through steering column.
 - A. Let switch hang freely.
 - B. Switch connector to vehicle wire harness.
 - C. Wiring protectors (33) and (34).
 - D. Support bracket (52).
 - E. Hex head bolts (53).

Tighten

- Tighten bolts (53) to 30.0 N·m (22 lb.ft.).

7. Turn signal switch assembly (10) and screws (7).

Tighten

- Tighten screws (7) to 3.4 N·m (30 lb.in.).

8. Signal switch arm (9) and screw (8).

Tighten

- Tighten screw (8) to 2.3 N·m (20 lb.in.).

9. Hazard knob assembly and multi-function lever. (See Section 3F)
10. Thrust washer (12).
11. Upper bearing spring (6).

3F1B-6 STD STRG COL UNIT REPAIR (FLR SHFT)

12. Turn signal cancelling cam assembly (5).
 - Lubricate with grease, synthetic (service kit).
13. Shaft lock (4).
14. New shaft lock retaining ring (3) using J 23653-C to push down shaft lock (4).
 - Ring (3) must be firmly seated in groove on shaft.
15. Shaft lock cover (2).

NOTICE: Gently pull lower turn signal wires to remove any wire kinks that may be inside steering column assembly. Failure to do so may cause damage to wire harness.

16. Refer to Section 3F to complete remaining steering column assembly.
17. Negative (-) battery cable.

SUB SECTION B - HOUSING COVER

INCLUDES:

**STEERING SHAFT ASSEMBLY
TURN SIGNAL SWITCH ASSEMBLY
STRG COL HOUSING ASSEMBLY
SWITCH ACTUATOR PIVOT ASSEMBLY
SPRING & BOLT ASSEMBLY
BEARING ASSEMBLY
SWITCH ACTUATOR SECTOR
IGNITION SWITCH ACTUATOR ASM**

Tools Required:
J 23653-C Lock Plate Compressor

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. Refer to service procedures in Section 3F.

Remove or Disconnect *Figures 1 through 17 and 21*

1. Negative (-) battery cable.
2. Steering column from vehicle. (See Section 3F)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage. (See Figure 21)
3. Do all steps, "Remove or Disconnect", Sub Section A.
 4. Steering shaft assembly (35).
 - Retaining ring (34) from shaft (35).
 - Dispose of ring (34).

Inspect

- Steering column shaft assembly (35) for accident damage. (See Figure 21)

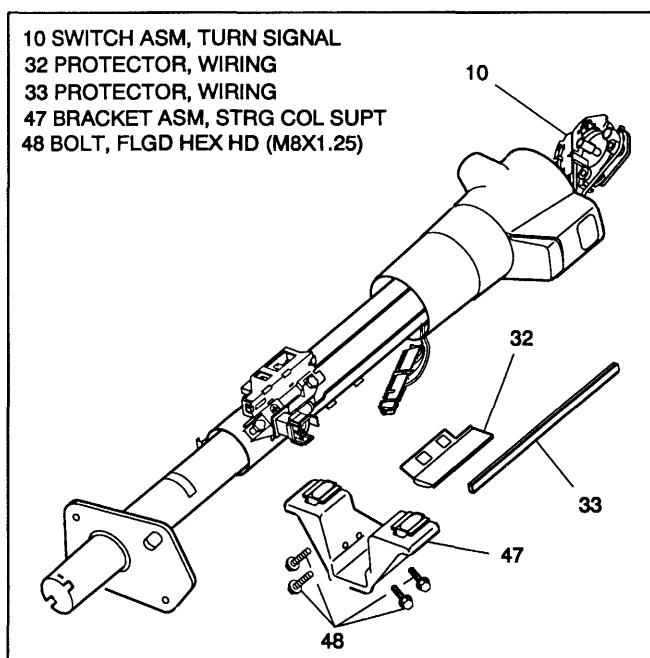


Figure 8 - Removing Turn Signal Switch

5. Four support bolts (48).
6. Steering column support bracket assembly (47).
7. Wiring protectors (32) and (33).
8. Turn signal switch assembly (10).
9. Washer head screw (44).
10. Hexagon nut (42).

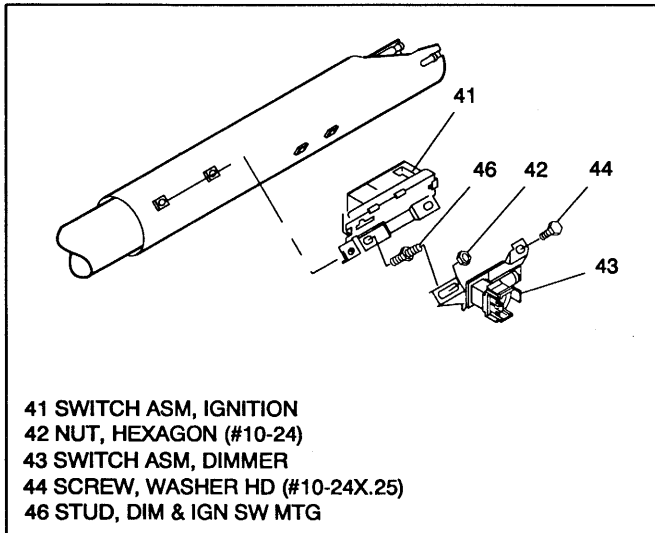


Figure 9 - Removing Dimmer & Ignition Switch Assemblies

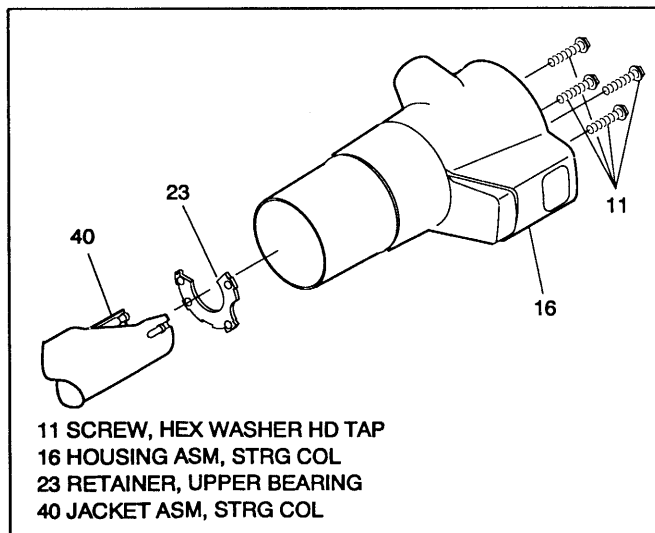


Figure 10 - Removing Lock Housing Cover Assembly

11. Dimmer switch (43).
12. Dimmer switch rod (45).
13. Dimmer & ignition switch mounting stud (46).
14. Ignition switch assembly (41).
15. Washer head tapping screw (11).

16. Lock housing cover assembly (16) with floor shift lever bowl (37) and gearshift bowl shroud (39).
 - Pull housing cover from jacket (40) and remove upper bearing retainer (23).
17. Three cross recess screws (38).
18. Floor shift lever bowl (37) with gearshift bowl shroud (39).
 - Shroud (39) from bowl (37).

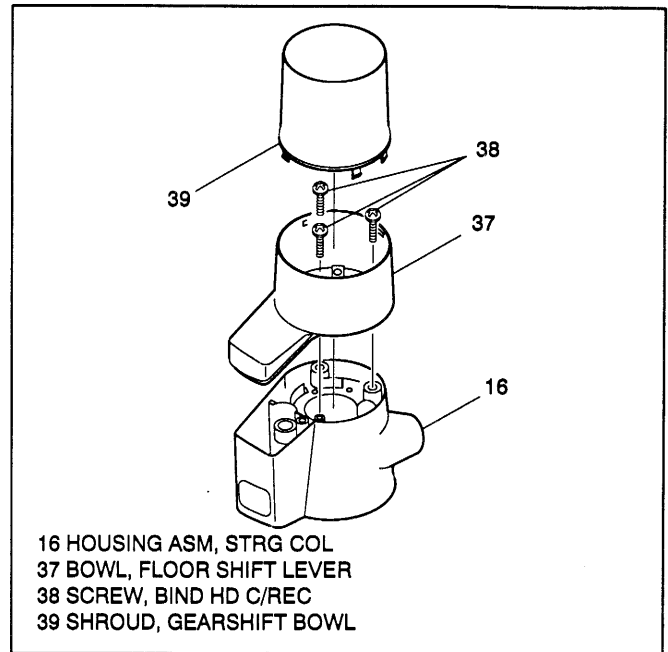


Figure 11 - Removing Shift Lever Bowl With Shroud

Important

- Remove only those components necessary to do repairs.

Disassemble

Steering Column Housing Assembly

NOTICE: Key release lever (28) is under spring tension. Care must be taken not to lose key release spring (29) or wave washer (27).

- A. Wave washer (27).
- B. Key release lever (28).

- C. Key release spring (29).
- D. Switch actuator rack (20) with spring & bolt assembly (26).
 - Spring & bolt assembly (26) from switch actuator rack (20).
 - Spring thrust washer (22) from spring & bolt assembly (26).
- E. Switch actuator sector (17).
- F. Rack preload spring (19).
- G. Switch actuator pivot pin (30).
 - Switch actuator pivot assembly (31).
- H. Bearing retaining bushing (24) using a punch.
- I. Bearing assembly (25) using a punch.

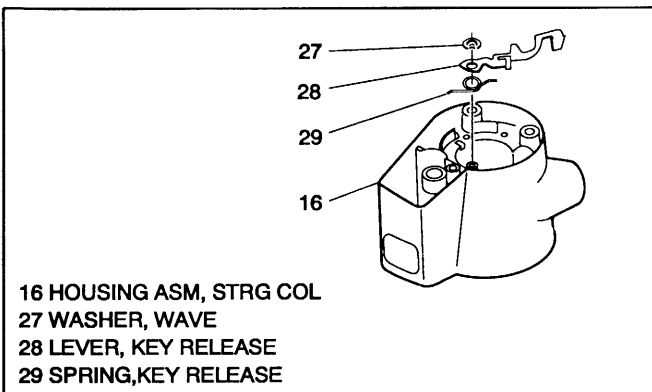


Figure 12 - Removing Key Release Lever Assembly

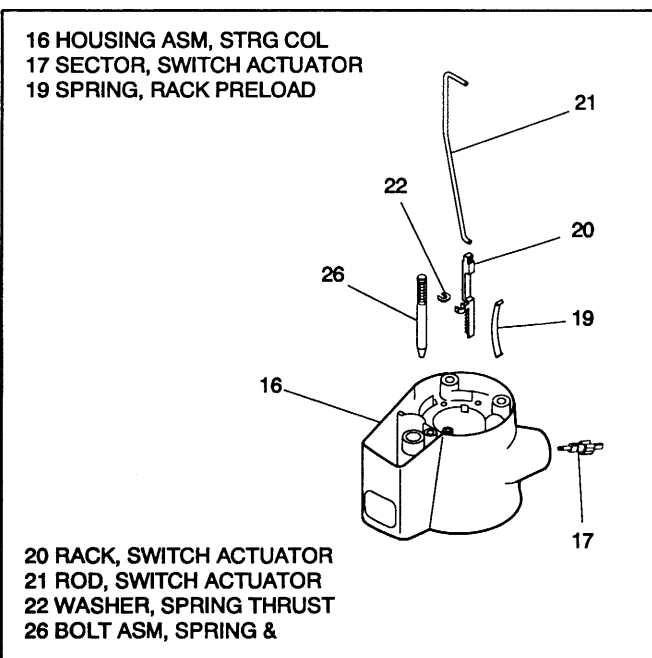


Figure 13 - Removing Switch Actuator Rack With Spring & Bolt Assembly

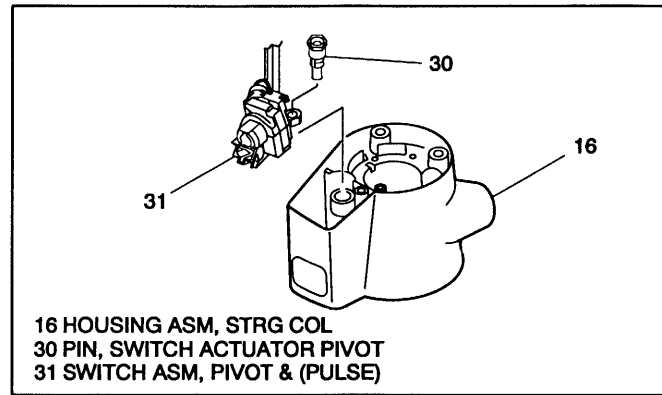


Figure 14 - Removing Switch Actuator Pivot Assembly

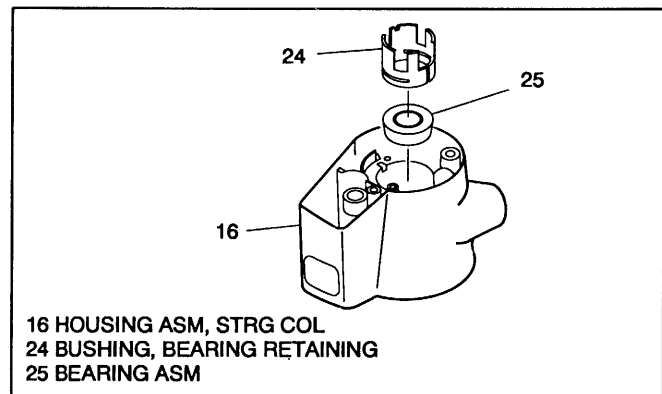


Figure 15 - Removing Bearing Retaining Bushing and Bearing Assembly



Steering Column Housing Assembly

NOTICE: Use bearing retaining bushing (24) to aid in seating bearing assembly into housing assembly (16). Tab on bushing (24) must be fully seated into slot in housing assembly (16).

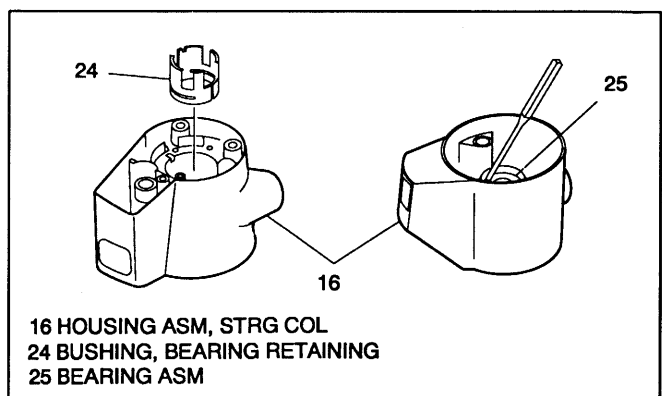


Figure 16 - Installing Bearing Assembly and Bearing Retaining Bushing

- A. Bearing assembly (25).
- B. Bearing retaining bushing (24).
- C. Switch actuator pivot assembly (31) with switch actuator pivot pin (30).

- G. Key release spring (29).
- H. Key release lever (28).
- I. Wave washer (27).

Tighten

- Tighten pin (30) to 3.1 N·m (27 lb.in.).
- D. Rack preload spring (19).
- E. Switch actuator sector (17).

Assemble

- Spring thrust washer (22) to spring & bolt assembly (26).

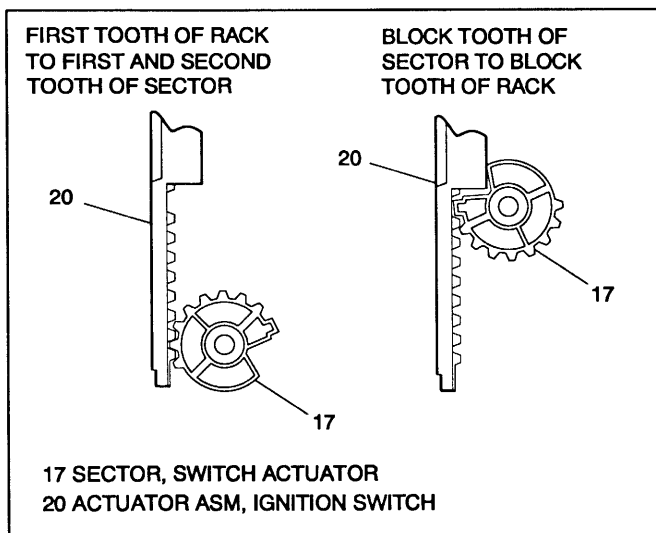


Figure 17 - Installing Switch Actuator Rack to Sector

- Spring & bolt assembly (26) to switch actuator rack (20).
- F. Spring & bolt assembly (26) with switch actuator rack (20) to housing assembly (16).

NOTICE: First tooth of rack (20) must interact with first and second tooth of sector (17). With rack (20) fully inserted, block tooth of sector (17) will rest in block tooth of rack (20).

Install or Connect *Figures 1, 18 and 19*

NOTICE: See "Notice" on page 3F1B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. New retaining ring (34) to shaft assembly (35).
2. Shaft assembly (35) to jacket assembly (40).
 - Lubricate with lithium grease.
3. Gearshift bowl shroud (39) to floor shift lever bowl (37).
4. Bowl (37) with shroud (39) to steering column housing assembly (16).
5. Three cross recess screws (38).

Tighten

- Tighten screws (38) to 1.9 N·m (17 lb.in.).

6. Turn signal switch (10) connector through column housing assembly (16).
7. Upper bearing retainer (23).
8. Lock housing cover assembly (16) with bowl (37) and shroud (39) to jacket assembly (40).
9. Cover screws (11).
 - Tighten screws (11) in a clockwise order finger tight.

Tighten

- Tighten screws (11) in same order to 5.3 N·m (47 lb.in.).

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10. Wiring protectors (32) and (33).
11. Support bracket (47).
12. Four support bolts (48).

Tighten

- Tighten bolts (48) to 30.0 N·m (22 lb.ft.).

NOTICE: Install ignition switch (41) to jacket (40) with switch in "OFF-LOCK" position. (See figure 18) New ignition switch will be pinned in "OFF-LOCK" position. Remove plastic pin after switch is assembled to column. Failure to do so may cause switch damage.

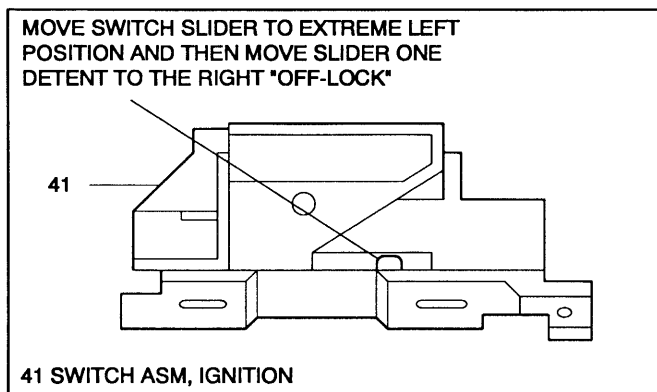


Figure 18 - Adjusting Ignition Switch

Adjust

- Ignition switch assembly (43). (See figure 18)
 - A. Move switch slider to extreme left position.
 - B. Move switch slider one detent to right "OFF-LOCK" position.
- 13. Ignition switch assembly (41) and dimmer & ignition switch mounting stud (46).

Tighten

- Tighten stud (46) to 4.0 N·m (35 lb.in.).
14. Dimmer switch rod (45).
 15. Dimmer switch assembly (43) to rod (45).
 16. Washer head screw (44) and hexagon nut (42).
 - Tighten finger tight.

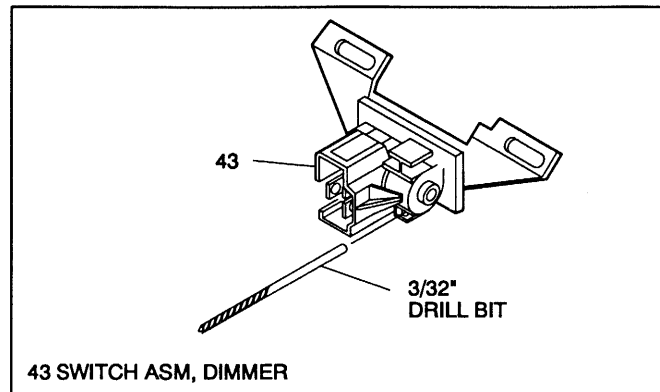


Figure 19 - Adjusting Dimmer Switch

Adjust

- Dimmer switch (43). (See Figure 19)
 - A. Place a 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod (45) to remove all lash.
 - C. Remove drill bit.

Tighten

- Tighten screw (44) and nut (42) to 4.0 N·m (35 lb.in.).

17. Do all steps, "Install or Connect", Sub Section A.

SUB SECTION C - LOWER COLUMN

INCLUDES:

**DIMMER SWITCH ASSEMBLY
DIMMER SWITCH ADJUSTMENT
IGNITION & DIMMER SWITCH ASM
IGNITION SWITCH ADJUSTMENT
ADAPTER & BEARING ASSEMBLY**

Dimmer Switch Assembly

Remove or Disconnect Figures 1 and 9

1. Negative (-) battery cable.
2. Washer head screw (44).

3. Hexagon nut (42).
4. Dimmer switch assembly (43) from rod (45).
5. Vehicle wire harness from dimmer switch (43).



Install or Connect

Figures 1,9 and 19

NOTICE: See "Notice" on page 3F1B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Dimmer switch assembly (43) to rod (45).
2. Washer head screw (44) and hexagon nut (42).
 - Tighten finger tight.



Adjust

- Dimmer switch (43). (See Figure 19)
 - A. Place 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod (45) to remove all lash.
 - C. Remove drill bit.



Tighten

- Tighten screw (44) and nut (42) to 4.0 N·m (35 lb.in.).
3. Vehicle wire harness to dimmer switch (43).
 4. Negative (-) battery cable.

Ignition Switch Assembly



Remove or Disconnect

Figures 1 and 9

1. Negative (-) battery cable.
2. Washer head screw (44).
3. Hexagon nut (42).
4. Dimmer switch assembly (43) from rod (45).

5. Dimmer & ignition switch mounting stud (46).
6. Ignition switch assembly (41) from ignition switch actuator rod (21).
7. Vehicle wire harness from ignition switch (41).



Install or Connect

Figures 1,9,18 and 19

NOTICE: See "Notice" on page 3F1B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

NOTICE: Install ignition switch (41) to jacket (40) with switch in "OFF-LOCK" position. (See Figure 18) New ignition switch will be pinned in "OFF-LOCK" position. Remove plastic pin after switch is assembled to column. Failure to do so may cause switch damage.

1. Ignition switch assembly (41) to ignition switch actuator rod (21).



Adjust

- Ignition switch assembly (41). (See Figure 18)
 - A. Move switch slider to extreme left position.
 - B. Move switch slider one detent to right "OFF-LOCK" position.

2. Ignition switch assembly (41) and dimmer & ignition switch mounting stud (46).



Tighten

- Tighten stud (46) to 4.0 N·m (35 lb.in.).
3. Dimmer switch assembly (43) to rod (45).
 4. Washer head screw (44) and hexagon nut (42).
 - Tighten finger tight.



Adjust

- Dimmer switch (43). (See Figure 19)
 - A. Place 3/32-inch drill bit in hole on switch to limit travel.

- B. Position switch on column and push against dimmer switch rod (45) to remove all lash.
- C. Remove drill bit.

Tighten

- Tighten screw (44) and nut (42) to 4.0 N·m (35 lb.in.).
5. Vehicle wire harness to ignition switch (41).
 6. Negative (-) battery cable.

Adapter & Bearing Assembly

Remove or Disconnect Figures 1, 20 and 21

1. Negative (-) battery cable.
2. Steering column from vehicle. (See Section 3F)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage. (See Figure 21)

Install or Connect Figures 1 and 20

NOTICE: See "Notice" on page 3F1B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

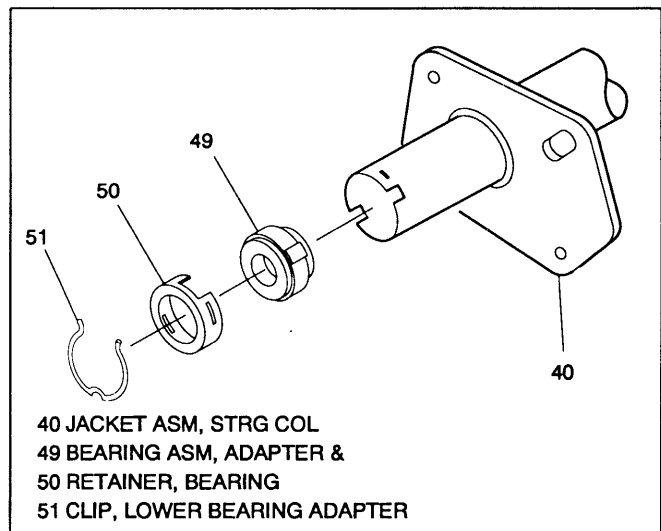


Figure 20 - Installing Adapter & Bearing Assembly

1. Adapter & bearing assembly (49).
 - Lubricate outer surface with lithium grease.
2. Bearing retainer (50).
3. Lower bearing adapter clip (51).
4. Steering column to vehicle. (See Section 3F)
5. Negative (-) battery cable.

CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

NOTICE: Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, or where the steering column has been impacted may also have a damaged or misaligned steering column.

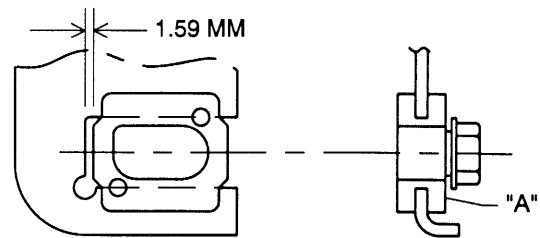
CHECKING PROCEDURE

JACKET ASM, STEERING COLUMN

- Check capsules on steering column bracket assembly; all should be within 1.59mm from the bottom of the slots (View A). If not, bracket should be replaced if bracket is bolted to the jacket asm or the jacket asm should be replaced if bracket is welded to jacket asm.
- Check contact surface "A" on capsules (View B). The bolt head must not contact surface "A" or shear load would be increased. If contact is made, replace bracket asm or jacket asm.
- Check for jacket asm collapse by measuring the distance from the lower edge of upper jacket to a defined point on the lower jacket (View D). If measured dimensions are not within specifications, a new jacket must be installed.

STEERING SHAFT ASM

- Visually inspect steering shaft for sheared injected plastic (View C). If steering shaft shows sheared plastic, a new steering shaft must be installed.
- Any frame damage that could cause a bent steering shaft must have steering shaft runout checked in the following manner: Using a dial indicator at lower end of steering shaft, have steering wheel rotated. Runout must not exceed 1.59mm.



VIEW A

(CAPSULES)

VIEW B

CAPSULES MUST BE WITHIN 1.59 MM FROM BOTTOM OF SLOTS;

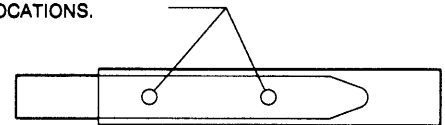
IF NOT, REPLACE BRACKET OR JACKET.

THE BOLT HEAD MUST NOT CONTACT SURFACE "A". IF CONTACT IS MADE, THE CAPSULE SHEAR LOAD WILL BE INCREASED.

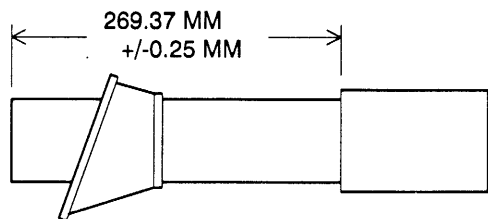
REPLACE BRACKET OR JACKET.

CHECK FOR SHEARED INJECTED PLASTIC AT THESE LOCATIONS.

VIEW C
(STEERING SHAFT)



VIEW D



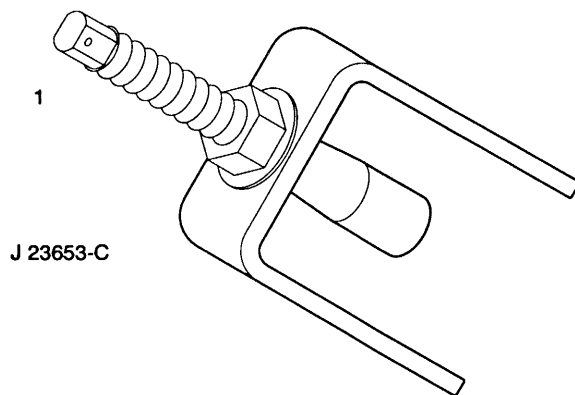
(METHOD TO DETERMINE COLUMN COLLAPSE) WITH LOWER BEARING REMOVED MEASURE DISTANCE BETWEEN ARROWS.

Figure 21 - Checking Steering Column for Accident Damage

SPECIFICATIONS

FASTENER TORQUES

1	Steering Wheel-to-Shaft Nut	41.0 N·m (30 lb.ft.)
7	Turn Signal Switch Connecting Screws	3.4 N·m (30 lb.in.)
8	Turn Signal Switch Actuator Assembly Screw	2.3 N·m (20 lb.in.)
11	Lock Housing Cover Screws	5.3 N·m (47 lb.in.)
15	Lock Retaining Screw	4.5 N·m (40 lb.in.)
30	Switch Actuator Pivot Pin	3.1 N·m (27 lb.in.)
38	Floor Shift Bowl to Steering Column Housing Screws	1.9 N·m (17 lb.in.)
42	Lower Ignition & Dimmer Switch Mounting Nut	4.0 N·m (35 lb.in.)
44	Upper Ignition & Dimmer Switch Screw	4.0 N·m (35 lb.in.)
46	Lower Ignition & Dimmer Switch Mounting Stud	4.0 N·m (35 lb.in.)
48	Support Bracket Bolts	30.0 N·m (22 lb.ft.)



1 LOCK PLATE COMPRESSOR

Figure 22 - Special Tools

SECTION 3F2A**TILT STEERING COLUMN
COLUMN SHIFT
UNIT REPAIR**

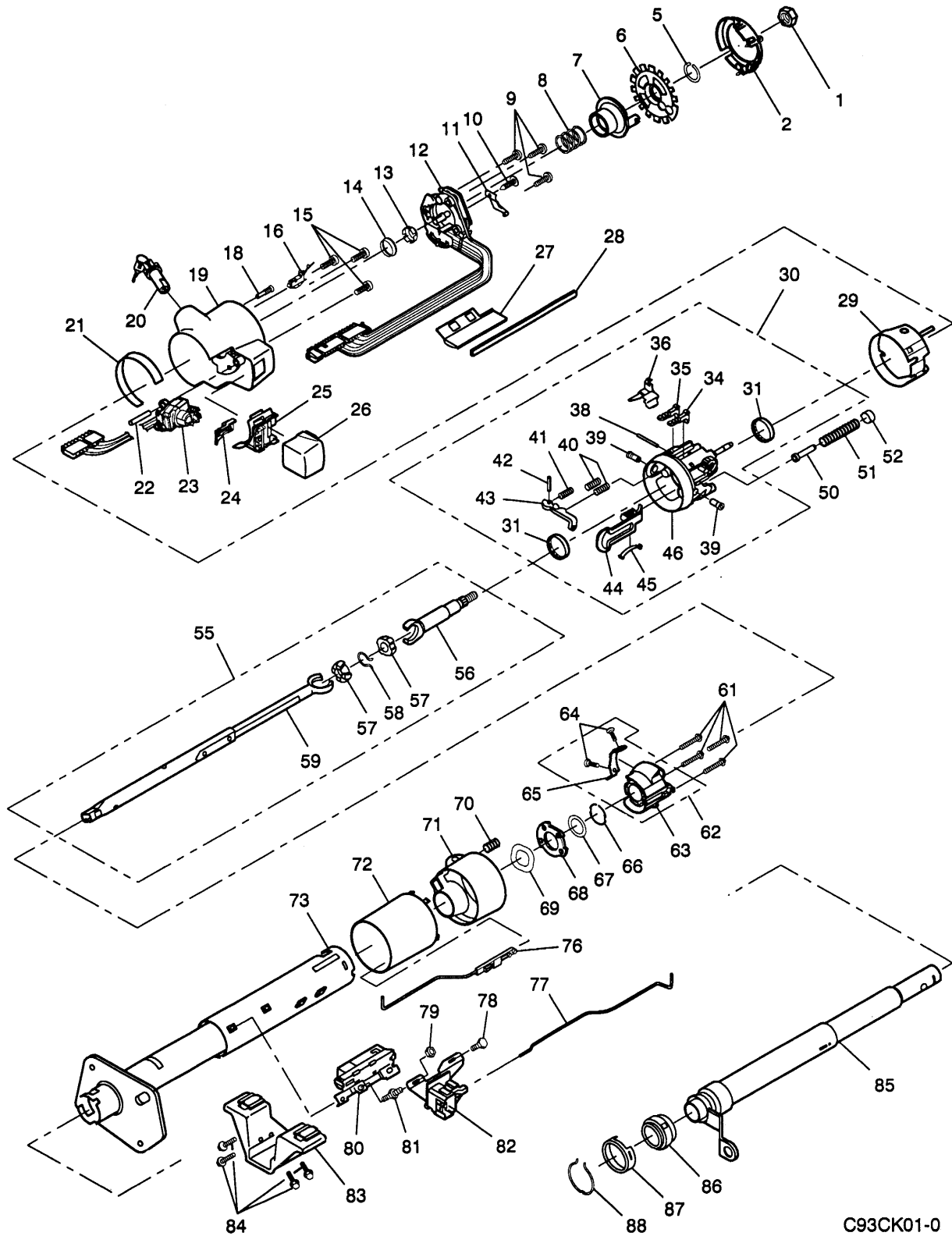
CAUTION: Before removing or installing any electrical unit or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "off" or "lock" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Inner Race		Sub Section D - Lower Column	3F2A-14
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Buzzer Switch Assembly		Dimmer Switch Adjustment	
Strg Col Lock Cylinder Set		Ignition Switch Assembly	
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Steering Column Housing Assembly			

3F2A-2 TILT STRG COL UNIT REPAIR (COL SHFT)



C93CK01-0

Figure 1 - Tilt Steering Column

1- NUT, HEX AGON JAM	57- SPHERE, CENTERING
2- GUARD ASM, LOCK BOLT	58- SPRING, JOINT PRELOAD
5- RING, RETAINING	59- SHAFT ASM, LOWER STEERING
6- LOCK, SHAFT	61- SCREW, SUPPORT
7- CAM ASM, TURN SIG CANCEL	62- SUPPORT ASM, STRG COL HSG
8- SPRING, UPPER BEARING	63- SUPPORT, STRG COL HSG
9- SCREW, BNDG HD CR RECESS	64- SCREW, OVL HD CROSS RECESS
10- SCREW, RD WASH HD (M4.2x1.41)	65- GATE, SHIFT LEVER
11- ARM, SIGNAL SWITCH	66- RING, SHIFT TUBE RETAINING
12- SWITCH ASM, TURN SIGNAL	67- WASHER, THRUST
13- SEAT, UPPER BRG INNER RACE	68- PLATE, LOCK
14- RACE, INNER	69- WASHER, WAVE
15- SCREW, PAN HD SOC TAP	70- SPRING, SHIFT LEVER
16- SWITCH ASM, BUZZER	71- BOWL ASM, GEARSHIFT LEVER
18- SCREW, LOCK RETAINING	72- SHROUD, GEARSHIFT BOWL
19- COVER ASM, LOCK HOUSING	73- JACKET ASM, STRG COL
20- LOCK CYLINDER SET, STRG COL	76- ACTUATOR ASM, IGN SWITCH
21- RING, COVER TRIM	77- ROD, DIMMER SWITCH
22- PIN, SWITCH ACTUATOR PIVOT	78- SCREW, WASH HD (#10-24x.25)
23- SWITCH ASM, PIVOT & (PULSE)	79- NUT, HEXAGON (#10-24)
24- ACTUATOR, DIMMER SW ROD	80- SWITCH ASM, IGNITION
25- BASE PLATE, COL HSG COVER END	81- STUD, DIM & IGN SW MTG
26- CAP, COL HSG COVER END	82- SWITCH ASM, DIMMER
27- PROTECTOR, WIRING	83- BRACKET ASM, STRG COL SUPT
28- PROTECTOR, WIRING	84- BOLT, FLGD HEX HD (M8X1.25)
29- COVER LINER ASM, PIN &	85- TUBE ASM, SHIFT
30- HOUSING ASM, STRG COLUMN	86- BEARING ASM, ADAPTER &
31- BEARING ASM	87- RETAINER, BEARING
34- SHOE, STEERING WHEEL LOCK	88- CLIP, LOWER BEARING ADAPTER
35- SHOE, STEERING WHEEL LOCK	
36- SHIELD, WIRE PROTECTOR	
38- PIN, DOWEL	
39- PIN, PIVOT	
40- SPRING, SHOE	
41- SPRING, RELEASE LEVER	
42- PIN, RELEASE LEVER	
43- LEVER, SHOE RELEASE	
44- RACK, SWITCH ACTUATOR	
45- SPRING, RACK PRELOAD	
46- HOUSING, STRG COLUMN	
50- GUIDE, SPRING	
51- SPRING, WHEEL TILT	
52- RETAINER, SPRING	
55- SHAFT ASM, STEERING	
56- SHAFT ASM, RACE & UPPER	

Service Kits

- 201-SPRING SERV KIT, TILT COLUMN
-INCLUDES: 13,14,39,50,51,52
- 202-COVER & SCR SERV KIT, LOCK HSG
-INCLUDES: 18,19
- 203-SPHERE SERV KIT, TILT COLUMN
-INCLUDES: 57,58
- 204-GREASE SERV KIT, (SYNTHETIC)

Figure 2 - Tilt Steering Column - Legend

SUB SECTION A - UPPER COLUMN

INCLUDES:

SHAFT LOCK
TURN SIGNAL CANCELLING CAM ASM
UPPER BEARING SPRING
UPPER BEARING INNER RACE SEAT
INNER RACE
TURN SIGNAL SWITCH ASSEMBLY
BUZZER SWITCH ASSEMBLY
STRG COL LOCK CYLINDER SET

Tools Required:

J 23653-C Lock Plate Compressor

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

Remove or Disconnect Figures 1 through 7

- Negative (-) battery cable.

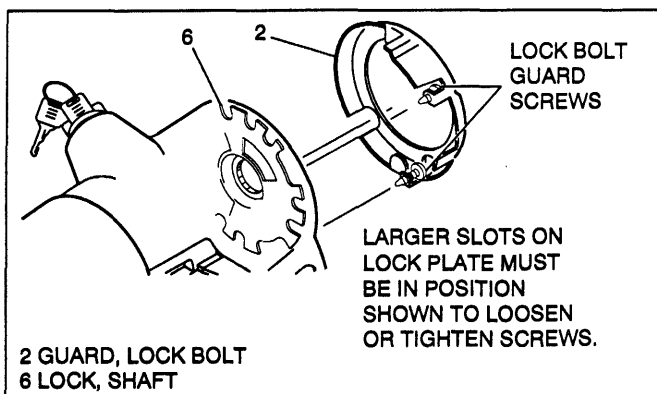


Figure 3 - Removing Lock Bolt Guard

- Lock bolt guard (2). (See Figure 3)
 - Place ignition switch to "RUN" position.
 - Rotate shaft (55) until block tooth is at 7 o'clock position and bolt guard screws are accessible through wide slots in shaft lock (6).

- Loosen screws on lock bolt guard (2) until guard can be removed (screws will be retained with lock bolt guard (2)).
- Place ignition switch to "LOCK" position.

- Shaft lock retaining ring (5) using J 23653-C to push down shaft lock (6).
 - Dispose of ring (5).

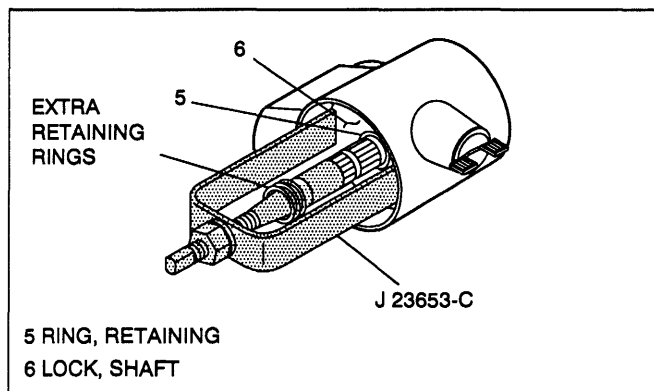


Figure 4 - Removing Shaft Lock Retaining Ring

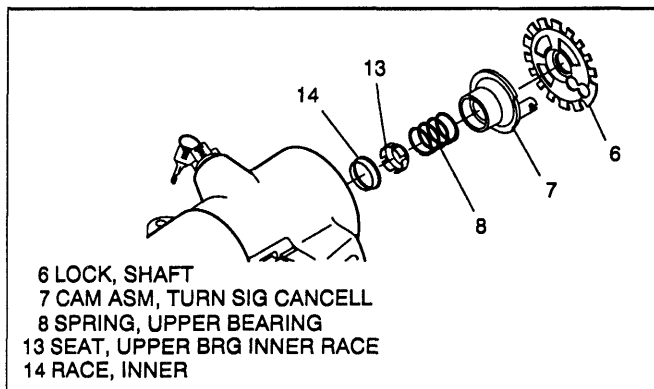


Figure 5 - Removing Components from Upper Shaft

- Shaft lock (6).
- Turn signal cancelling cam assembly (7).
- Upper bearing spring (8).
- Upper bearing inner race seat (13).
- Inner race (14).
- Turn signal to "RIGHT TURN" position (up).
- Multi-function lever and hazard knob assembly. (See Section 3F)
- Screw (10) and signal switch arm (11).
- Turn signal switch screws (9).

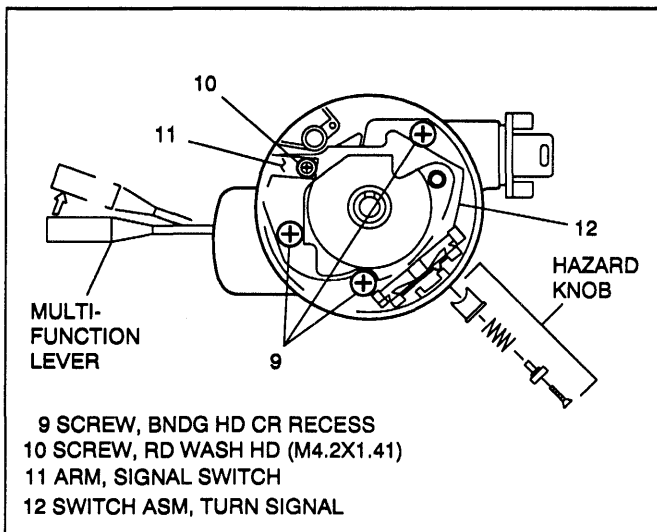


Figure 6 - Turn Signal Switch Removal Preparation

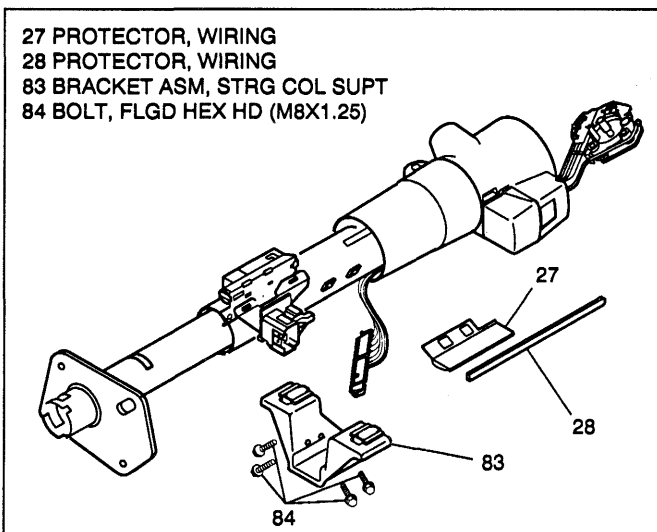


Figure 7 - Removing Turn Signal Switch

13. Turn signal switch assembly (12).
 - Let switch hang freely if removal is not needed.
 - To remove switch (12):
 - A. Hex head bolts (84).
 - B. Steering column support bracket assembly (83).
 - C. Turn signal switch connector from vehicle wire harness.
 - D. Wiring protectors (27) and (28).
 - E. Gently pull wire harness through column.
14. Key from steering column lock cylinder set (20).
15. Buzzer switch assembly (16).

16. Reinsert key in lock cylinder (20).
 - Key in "LOCK" position.
17. Lock retaining screw (18).
18. Lock cylinder (20).

Install or Connect
Figures 1, 2 and 8

NOTICE: See "Notice" on page 3F2A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do may result in component damage or malfunctioning of steering column.

1. Lock cylinder (20).
2. Lock retaining screw (18).

Tighten

- Tighten screw (18) to 2.5 N·m (22 lb.in.).
3. Key from lock cylinder set (20).
 4. Buzzer switch assembly (16).
 5. Reinsert key in lock cylinder set (20).
 - Key in "LOCK" position.

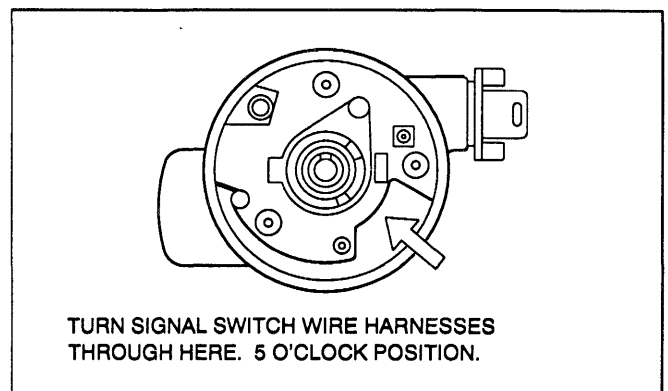


Figure 8 - Wire Harnesses through Column

6. Turn signal switch assembly (12) wire harness through steering column.
 - Let switch hang freely.
 - Switch connector to vehicle wire harness.

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7. Turn signal switch assembly (12) and screws (9).

Tighten

- Tighten screws (9) to 3.4 N•m (30 lb.in.).

8. Signal switch arm (11) and screw (10).

Tighten

- Tighten screws (10) to 2.3 N•m (20 lb.in.).

9. Hazard knob assembly and multi-function lever.
(See Section 3F)
10. Inner race (14).
11. Upper bearing inner race seat (13).
12. Upper bearing spring (8).
13. Turn signal cancelling cam assembly (7).
 - Lubricate with grease, synthetic (service kit).
14. Shaft lock (6).
15. New shaft lock retaining ring (5) using J 23653-C to push down shaft lock (6).
 - Ring (5) must be firmly seated in groove on shaft.
16. Lock bolt guard (2). (See Figure 3)
 - A. Place ignition switch to "RUN" position.
 - B. Rotate shaft (55) until block tooth is at 7 o'clock position and bolt guard screw holes are accessible through wide slots in shaft lock (6).
 - C. Lock bolt guard (2) and tighten screws on guard until screw heads bottom out.

Tighten

- Tighten two bolts to 2.3 N•m (20 lb.in.).

Inspect

- Rotate shaft lock (6).
- Shaft lock (6) must not bind on guard screws or tabs on bolt guard (2).

NOTICE: Gently pull lower turn signal wires to remove any wire kinks that may be inside steering column assembly. Failure to do so may cause damage to wire harness.

17. Wiring protectors (27) and (28).
18. Support bracket (83).
19. Hex head bolts (84).

Tighten

- Tighten bolts (84) to 30.0 N•m (22 lb.ft.).

20. Refer to Section 3F to complete remaining steering column assembly.
21. Negative (-) battery cable.

SUB SECTION B - HOUSING COVER

Figures 1 through 12

INCLUDES:

**LOCK HOUSING COVER ASSEMBLY
COLUMN HSG COVER END CAP
PIVOT & (PULSE) SWITCH ASSEMBLY
DIMMER SWITCH ROD ACTUATOR
TILT SPRING ASSEMBLY**

Tools Required:

J 23653-C Lock Plate Compressor

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

Important

- Remove only those components necessary to do repairs.

Remove or Disconnect

1. Do all steps, "Remove or Disconnect", Sub Section A.
2. Housing cover end cap (26).

3. Cover screws (15).
4. Tilt lever. (See Section 3F)
5. Lock housing cover assembly (19).
6. Base plate (25) and dimmer switch rod actuator (24).
7. Wire protector shield (36).
8. Switch actuator pivot pin (22).

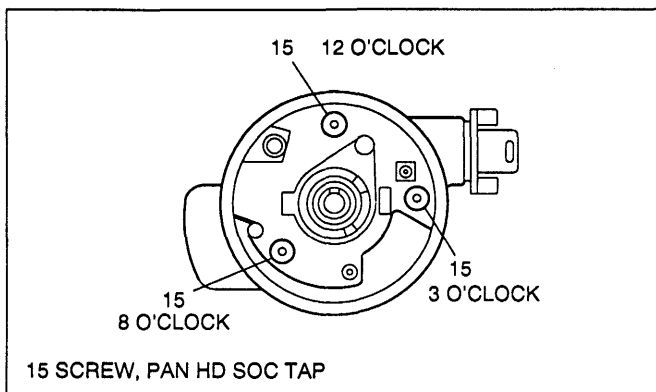


Figure 9 - Lock Housing Cover Screw Positions

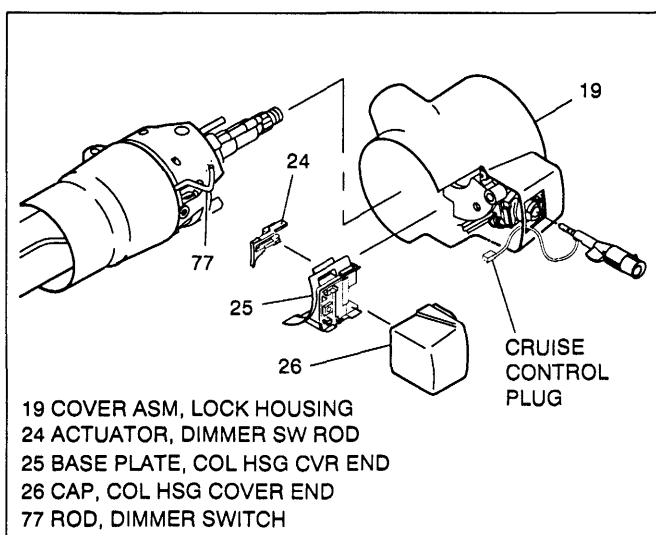


Figure 10 - Removing Lock Housing Cover

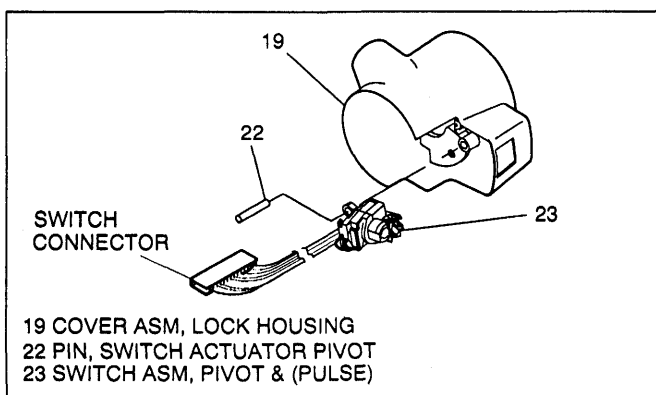


Figure 11 - Removing Pivot & (Pulse) Switch

9. Pivot & (pulse) switch assembly (23).
 - Let switch hang freely if removal is not needed.
 - To remove switch (23):
 - A. Pivot & (pulse) switch connector from vehicle wire harness.
 - B. Gently pull wire harness through column.
10. Pin & cover liner assembly (29).
11. Cover trim ring (21).
12. Spring retainer (52).
 - Using a cross recess head screwdriver, push retainer down and turn counterclockwise to release.
13. Spring (51) and spring guide (50).

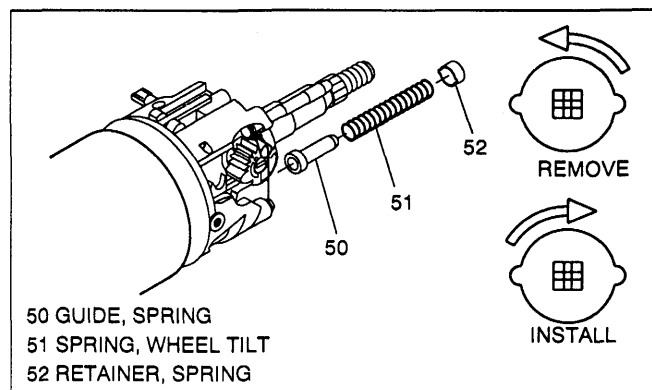


Figure 12 - Removing Tilt Spring Assembly

Install or Connect

NOTICE: See "Notice" on page 3F2A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Spring guide (50) and spring (51).
 - Lubricate with lithium grease.
2. Spring retainer (52).
 - Using a cross recess screwdriver push retainer down and turn clockwise to lock in place.
3. Cover trim ring (21).
4. Pin & cover liner assembly (29).

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5. Pivot & (pulse) switch assembly (23) to lock housing cover assembly (19).
6. Switch actuator pivot pin (22) to switch (23) and cover (19).
7. Pivot & (pulse) switch wire harness through steering column.
 - Switch connector to vehicle wire harness.
 - Wire protector shield (36).
8. Dimmer switch rod actuator (21) to base plate (25).
 - Lubricate with lithium grease.
9. Base plate (25) to lock housing cover assembly (19).
 - Bottom edge of dimmer switch rod actuator (24) should rest on bend in dimmer switch rod (77).
10. Lock housing cover assembly (19).
11. Screws (15). Tighten screw in 12 o'clock position first, screw in 8 o'clock position second, and screw in 3 o'clock position third.

Tighten

- Tighten screws (15) in same order to 9.0 N·m (80 lb.in.).
12. Install multi-function lever. (See Section 3F)
 13. Housing cover end cap (26).
 14. Do all steps, "Install or Connect", Sub Section A.

SUB SECTION C - MID COLUMN

INCLUDES:

STEERING COLUMN HOUSING ASM
STEERING WHEEL LOCK SHOE
SWITCH ACTUATOR RACK
BEARING ASSEMBLY
STEERING COL HSG SUPPORT ASM
STEERING SHAFT ASSEMBLY
SHIFT TUBE ASSEMBLY

Tools Required:

- J 23653-C Lock Plate Compressor
- J 21854-01 Pivot Pin Remover
- J 22635 Lock Shoe and Release Lever Pin Remover and Installer
- J 8092 Driver Handle
- J 38639 Strg Col Housing Bearing Installer
- J 23072 Shift Tube Remover
- J 23073-01 Shift Tube Installer

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

Remove or Disconnect

Figures 1 through 29 and 31

1. Negative (-) battery cable.
2. Steering column from vehicle. (See Section 3F)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage (See Figure 31)
3. Do all steps, "Remove or Disconnect", Sub Section B.

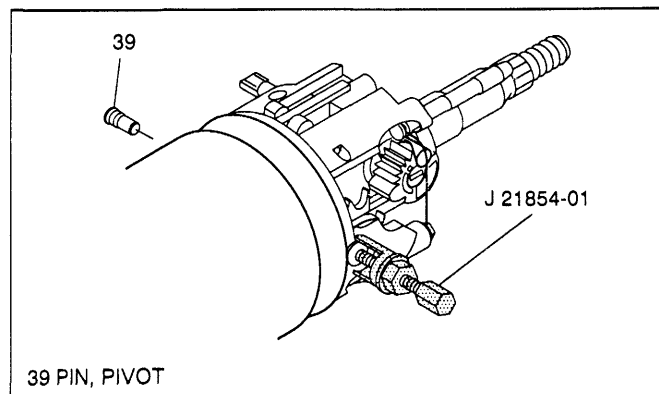


Figure 13 - Removing Pivot Pin

4. Pivot pins (39) using J 21854-01.
 - Reinstall tilt lever. (See Section 3F)
5. Steering column housing assembly (30).
 - Pull back on tilt lever and pull steering column housing assembly (30) down and away from column.

Important

- Remove only those components necessary to do repairs.

Disassemble

Steering Column Housing Assembly

- A. Bearing assembly (31).
- B. Switch actuator rack (44) and rack preload spring (45).
- C. Release lever pin (42) using J 22635.
- D. Shoe release lever (43).
- E. Release lever spring (41).
- F. Dowel pin (38) using J 22635.
- G. Lock shoes (34) and (35).
- H. Shoe springs (40).

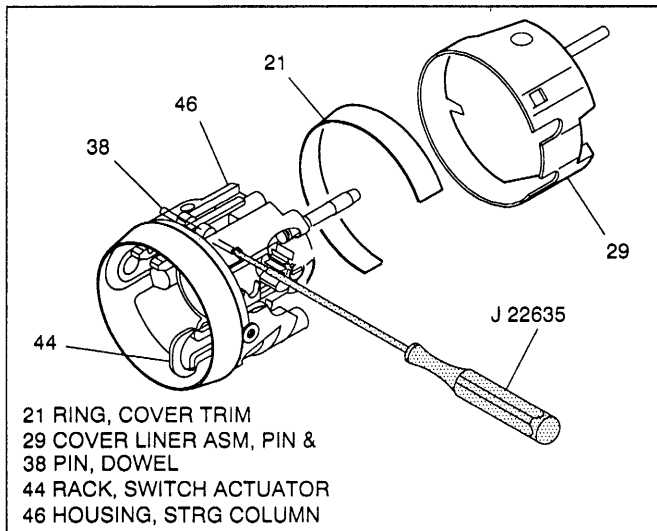


Figure 14 - Lock Housing Cover Components, Exterior

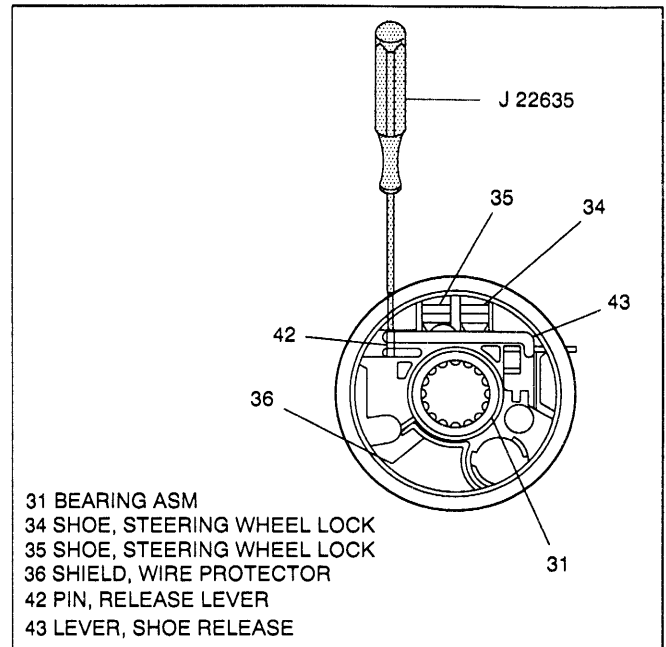


Figure 15 - Lock Housing Cover Components, Interior

Assemble

Steering Column Housing Assembly

- A. Shoe springs (40).
 - B. Lock shoes (34) and (35).
 - C. Dowel pin (38) using J 22635.
 - D. Release lever spring (41).
 - E. Shoe release lever (43).
 - F. Release lever pin (42) using J 22635.
 - G. Rack preload spring (45).
 - H. Switch actuator rack (44) to actuator sector.
 - I. Bearing assembly (31) lubricated with lithium grease to column housing (46) using J 38639 and J 8092.
6. Lower bearing adapter clip (88).
 7. Bearing adapter retainer (87).
 8. Adapter & bearing assembly (86).
 9. Steering column shaft assembly (55).

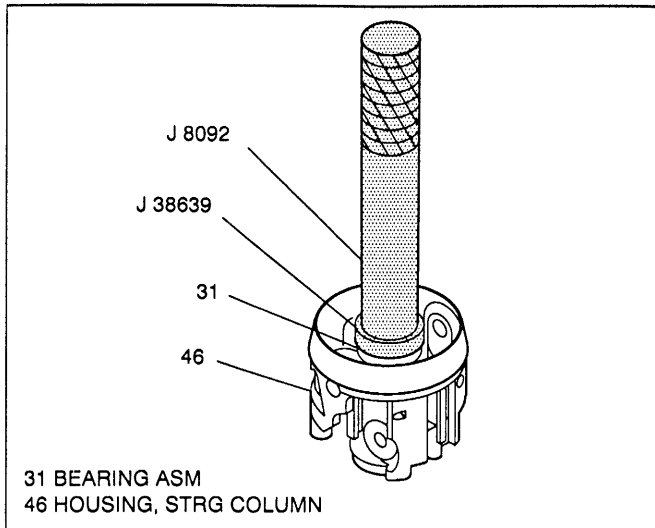


Figure 16 - Installing Bearings

Inspect

- Steering column shaft assembly (55) for accident damage. (See Figure 31)

Important

- Mark upper shaft assembly (56) and lower steering shaft assembly (59) to ensure proper assembly. Failure to assemble properly will cause steering wheel to be turned 180 degrees. (See Figures 17 and 18)

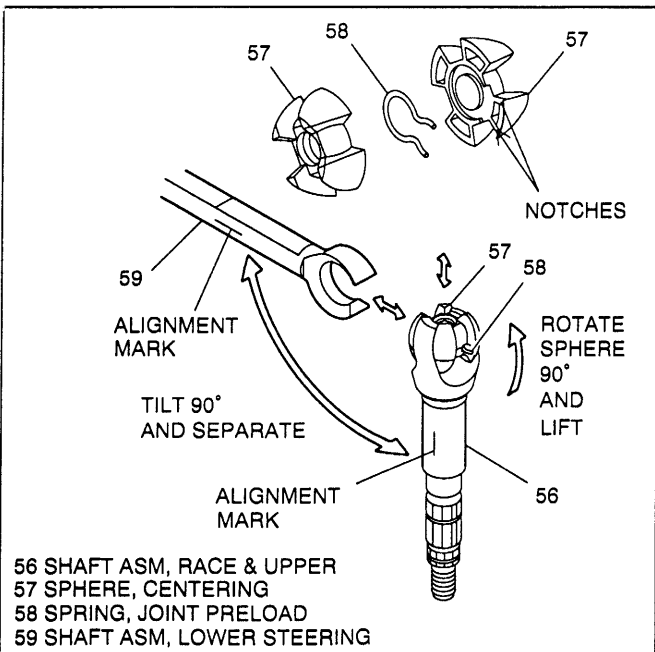


Figure 17 - Removing Steering Shaft Components

Important

- Remove only those components necessary to do repairs.

Disassemble

Steering Column Shaft Assembly

- Upper shaft assembly (56), lower steering shaft assembly (59).
 - Tilt 90 degrees to each other and disengage.
- Centering sphere (57) from upper shaft assembly (56).
 - Rotate sphere 90 degrees and slip out.
- Joint preload spring (58) from centering sphere (57).

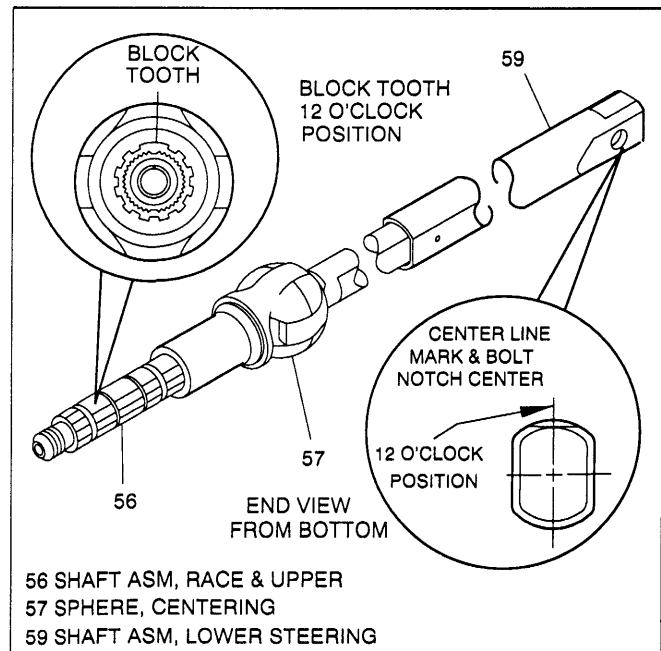


Figure 18 - Correct Upper to Lower Shaft Orientation

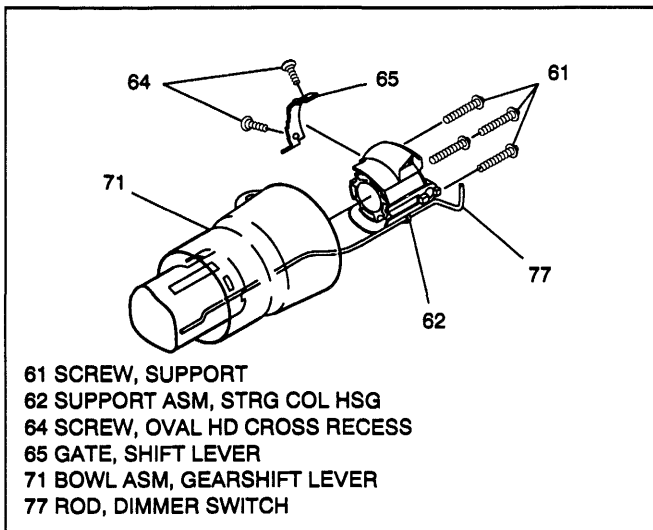


Figure 19 - Removing Column Housing Support

**Assemble****Steering Column Shaft Assembly**

- A. Joint preload spring (58) to two centering sphere (57).
 - B. Centering sphere (57).
 - Lubricate with lithium grease, slip into upper shaft assembly (56), and rotate sphere 90 degrees.
 - C. Upper shaft assembly (56) to lower steering shaft assembly (59).
 - Line up marks and tilt assemblies 90 degrees to each other.
10. Support screws (61).
 11. Column housing support assembly (62) with dimmer switch rod (77) from steering column jacket assembly (73).
 - Rod (77) from support (63).
 12. Oval hd cross recess screws (64) and shift lever gate (65) from support (63).
 13. Shift tube retaining ring (66).
 14. Thrust washer (67).

SHIFT TUBE LEVER MUST BE IN POSITION AS SHOWN WHEN REMOVING OR INSTALLING SHIFT TUBE ASSEMBLY

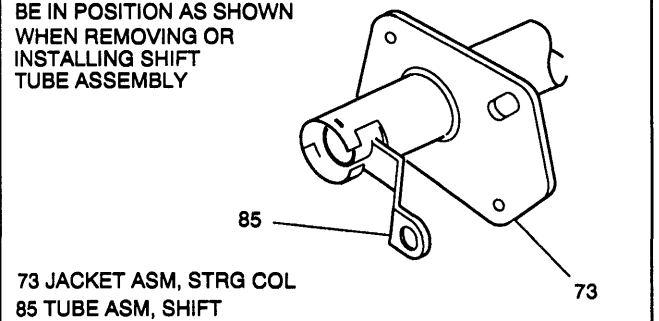


Figure 20 - Shift Tube Lever Position

NOTICE: Shift tube lever must be in position to clear jacket assembly (73) when removing shift tube (85). Forcing lever against jacket may cause damage to jacket assembly (73). (See Figure 20)

15. Shift tube (85) using J 23072.
16. Lock plate (68).
17. Wave washer (69).
18. Gearshift lever bowl (71) with gearshift bowl shroud (72).
19. Shift lever spring (70) from bowl (71).
20. Shroud (72) from bowl (71).

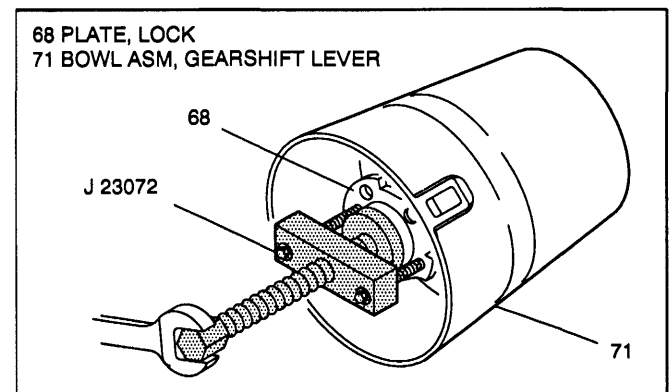


Figure 21 - Removing Shift Tube

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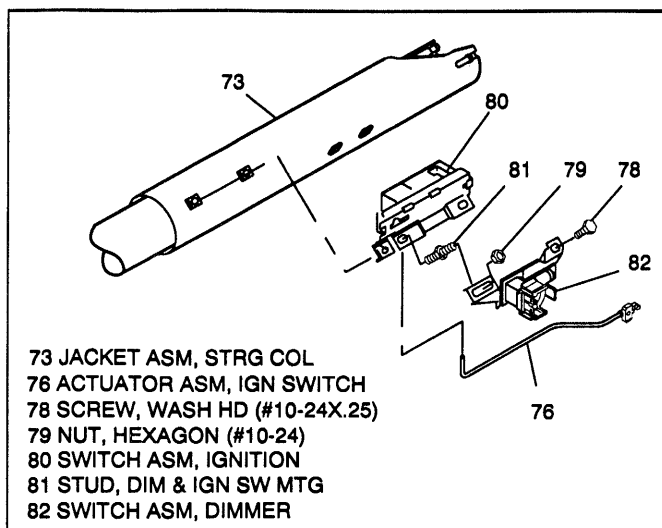


Figure 22 - Removing Ignition and Dimmer Switches

21. Hexagon Nut (79) and washer head screw (78).
22. Dimmer switch assembly (82).
23. Dimmer & ignition switch mounting stud (81).
24. Ignition switch assembly (80) with switch actuator assembly (76).

- Switch actuator assembly (76) from ignition switch assembly (80).

Install or Connect

NOTICE: See "Notice" on page 3F2A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Bowl (71) to shroud (72).
2. Spring (70) to bowl (71).
3. Shroud (72) with bowl (71) to jacket (73).
4. Wave washer (69).
 - Lubricate with lithium grease.
5. Lock plate (68).

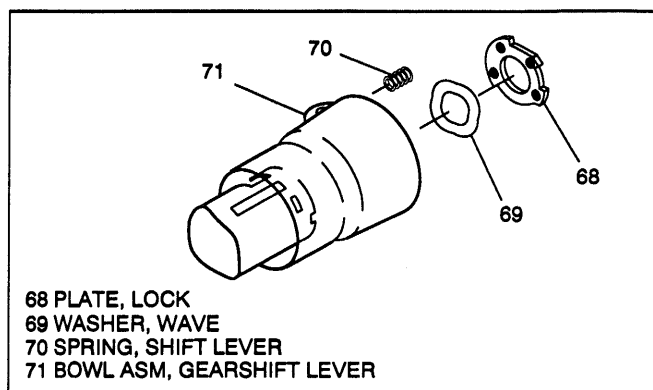


Figure 23 - Installing Lock Plate, Wave Washer

NOTICE: Shift tube lever must be in position to clear jacket assembly (73) when installing shift tube (85). Forcing lever against jacket may cause damage to jacket assembly (73). (See Figure 20)

6. Shift tube (85) using J 23073-01.

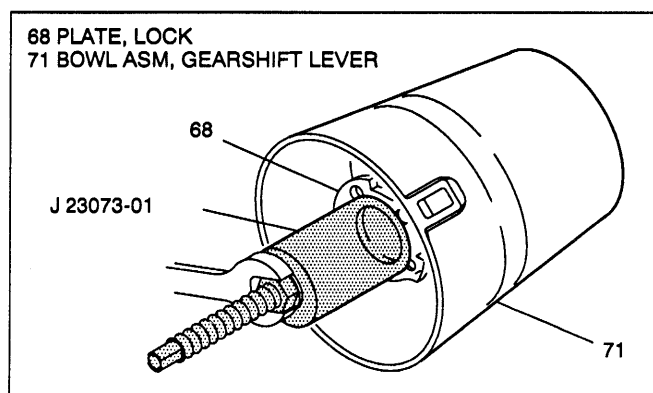


Figure 24 - Installing Shift Tube

7. Thrust washer (67).
8. Retaining ring (66).
9. Gate (65) and screws (64) to support (63).

Tighten

- Tighten screws (64) to 3.7 N·m (33 lb.in.).
10. Dimmer switch rod (77) to column housing support assembly (62).

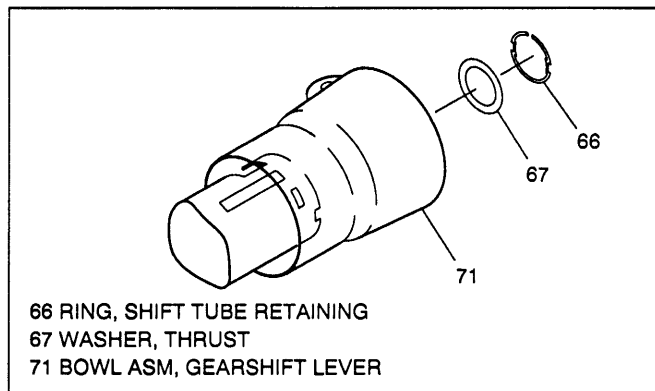


Figure 25 - Installing Shift Tube Retaining Ring, Thrust Washer

11. Support assembly (62) and screw (61).

Tighten

- Tighten screw (61) to 8.8 N·m (77 lb.in.).
12. Column shaft assembly (55) to jacket assembly (73).
 - Lubricate with lithium grease.
 13. Tilt lever. (See Section 3F)
 14. Steering column housing assembly (30) to column.
 - A. Position column housing (30) and align switch actuator rack (44) with pin on end of ignition switch actuator assembly (76).
 - B. Pull back on tilt lever, pushing column housing assembly (30) onto column housing support assembly (62).
 - C. Release tilt lever to lock shoes (34) and (35) onto dowel pins.
 - D. Remove tilt lever. (See Section 3F)
 15. Pivot pins (39).
 - A. Lubricate with lithium grease.
 - B. Press pin until firmly seated, two places.
 16. Adapter & bearing assembly (86).
 - Lubricate inner surface of bearing (86) with lithium grease.

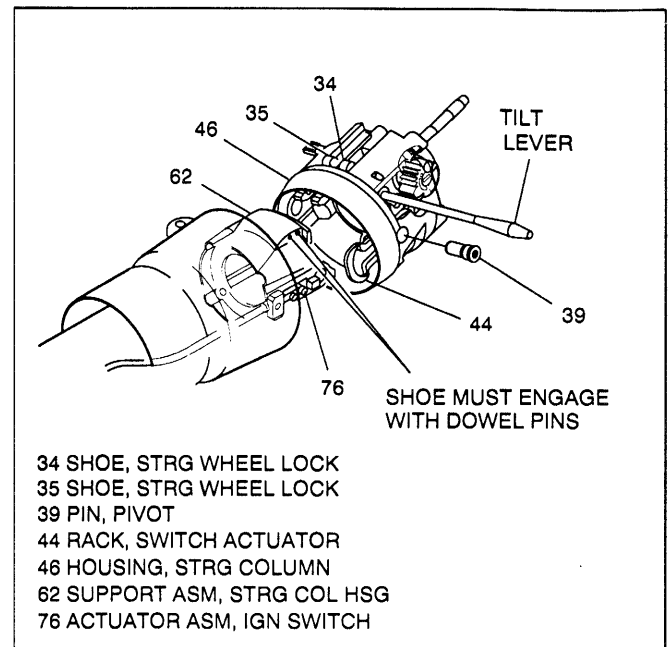


Figure 26 - Installing Column Housing to Housing Support

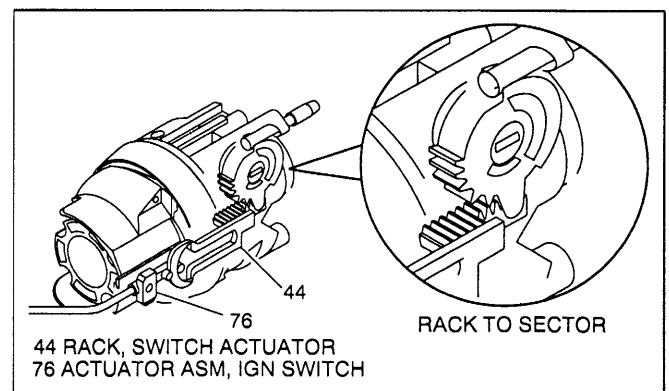


Figure 27 - Actuator Assembly to Actuator Rack Installed

17. Bearing adapter retainer (87).
18. Lower bearing adapter clip (88).
19. Do steps 1 through 13 "Install or Connect", Sub Section B.
20. Do steps 1 through 20, "Install or Connect", Sub Section A.
21. Do all steps, Ignition Switch Assembly, "Install or Connect", Sub Section D.

SUB SECTION D - LOWER COLUMN

INCLUDES:

**DIMMER SWITCH ASSEMBLY
DIMMER SWITCH ADJUSTMENT
IGNITION SWITCH ASSEMBLY
IGNITION SWITCH ADJUSTMENT
ADAPTER & BEARING ASSEMBLY**

Dimmer Switch Assembly

Remove or Disconnect Figures 1,2 and 22

1. Negative (-) battery cable.
2. Washer head screw (78).
3. Hexagon nut (79).
4. Dimmer switch assembly (82).
 - Dimmer switch (82) from vehicle wire harness.

Install or Connect Figures 1,2,22 and 28

NOTICE: See "Notice" on page 3F2A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Dimmer switch assembly (82) to rod (77).
2. Hex nut (79) and washer head screw (78).
 - Tighten finger tight.

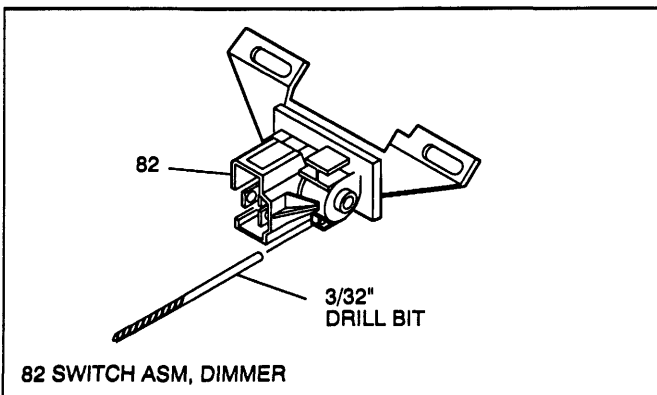


Figure 28 - Adjusting Dimmer Switch

Adjust

- Dimmer switch (82). (See Figure 28)
 - A. Place 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod (77) to remove all lash.
 - C. Remove drill bit.

Tighten

- Tighten screw (78) and nut (79) to 4.0 N·m (35 lb.in.).
3. Vehicle wire harness to dimmer switch (82).
 4. Negative (-) battery cable.

Ignition Switch Assembly

Remove or Disconnect Figures 1,2 and 22

1. Negative (-) battery cable.
2. Washer head screw (78).
3. Hexagon nut (79).
4. Dimmer switch assembly (82) from rod (77).
5. Dimmer & ignition switch mounting stud (81).
6. Ignition switch assembly (80) from ignition switch actuator assembly (76).
 - Ignition switch (80) from vehicle wire harness.

Install or Connect Figures 1,2,22,28 and 29

NOTICE: See "Notice" on page 3F2A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Lock cylinder (20) to "OFF-LOCK" position.

NOTICE: Install ignition switch (80) to jacket (73) with switch in "OFF-LOCK" position. (See Figure 29) New ignition switch will be pinned in "OFF-LOCK" position. Remove plastic pin after switch is assembled to column. Failure to do so may cause switch damage.

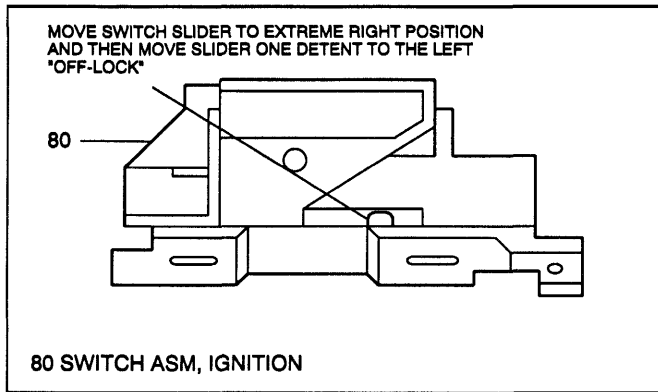


Figure 29 - Adjusting Ignition Switch

Adjust

- Ignition switch assembly (80). (See Figure 29)
 - A. Move switch slider to extreme right position.
 - B. Move switch slider one detent to left "OFF-LOCK" position.
- 2. Ignition switch assembly (80) and mounting stud (81).

Tighten

- Tighten stud (81) to 4.0 N·m (35 lb.in.).
- 3. Dimmer switch assembly (82).
- 4. Hex nut (79) and washer head screw (78).
 - Tighten finger tight.

Adjust

- Dimmer switch (82). (See Figure 28)
 - A. Place 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod (77) to remove all lash.
 - C. Remove drill bit.

Tighten

- Tighten nut (79) and screw (78) to 4.0 N·m (35 lb.in.).

- 5. Vehicle wire harness to ignition switch (80) and dimmer switch (82).
- 6. Negative (-) battery cable.

Adapter & Bearing Assembly

Figures 1,2,30 and 31

Remove or Disconnect

- 1. Negative (-) battery cable.
- 2. Steering column from vehicle. (See Section 3F)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage. (See Figure 31)

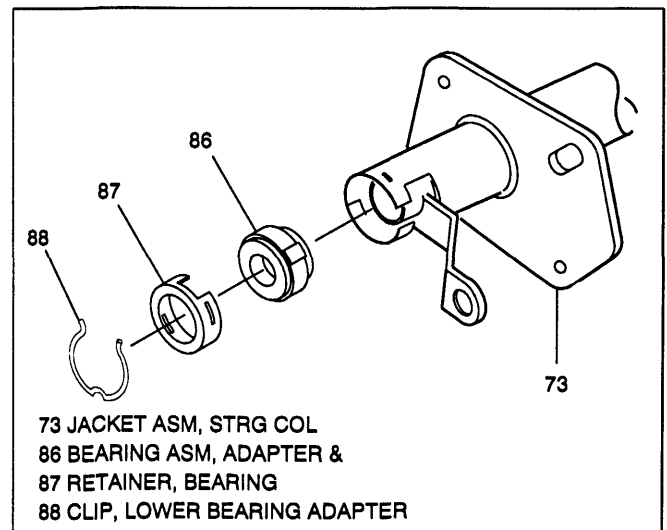


Figure 30 - Removing Adapter & Bearing Assembly

3F2A-16 TILT STRG COL UNIT REPAIR (COL SHFT)

3. Lower bearing adapter clip (88).
4. Bearing adapter retainer (87).
5. Adapter & bearing assembly (86).

Install or Connect

NOTICE: See "Notice" on page 3F2A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Adapter & bearing assembly (86).
 - Lubricate inner surface of bearing (86) with lithium grease.
2. Bearing adapter retainer (87).
3. Lower bearing adapter clip (88).
4. Steering column to vehicle. (See Section 3F)
5. Negative (-) battery cable.

CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

NOTICE: Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, or where the steering column has been impacted may also have a damaged or misaligned steering column.

CHECKING PROCEDURE

JACKET ASM, STEERING COLUMN

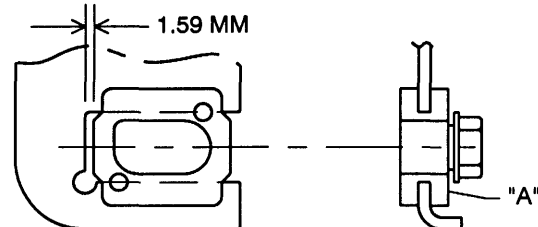
- Check capsules on steering column bracket assembly; all should be within 1.59mm from the bottom of the slots (View A). If not, bracket should be replaced if bracket is bolted to the jacket assembly or the jacket assembly should be replaced if bracket is welded to jacket assembly.
- Check contact surface "A" on capsules (View B). The bolt head must not contact surface "A" or shear load would be increased. If contact is made, replace bracket assembly or jacket assembly.
- Check for jacket assembly collapse by measuring the distance from the lower edge of upper jacket to a defined point on the lower jacket (View E). If measured dimensions are not within specifications, a new jacket must be installed.

SHIFT TUBE ASM

- Visually inspect shift tube for sheared injected plastic (View C). If shift tube shows sheared plastic, a new shift tube must be installed. Check operation of shift lever, if you can move lever to "Park" position without raising lever, it is an indication that upper shift tube plastic bearing is broken.

STEERING SHAFT ASM

- Visually inspect steering shaft for sheared injected plastic (View D). If steering shaft shows sheared plastic, a new steering shaft must be installed.
- Any frame damage that could cause a bent steering shaft must have steering shaft runout checked in the following manner: Using a dial indicator at lower end of steering shaft, have steering wheel rotated. Runout must not exceed 1.59mm.



VIEW A

(CAPSULES)

VIEW B

CAPSULES MUST BE WITHIN 1.59 MM FROM BOTTOM OF SLOTS;

IF NOT, REPLACE BRACKET OR JACKET.

THE BOLT HEAD MUST NOT CONTACT SURFACE "A". IF CONTACT IS MADE, THE CAPSULE SHEAR LOAD WILL BE INCREASED.

REPLACE BRACKET OR JACKET.

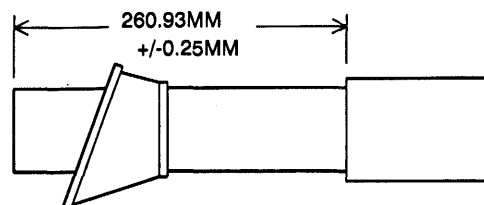
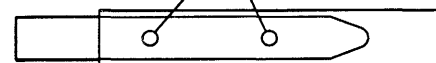
CHECK FOR SHEARED INJECTED PLASTIC AT THESE LOCATIONS.

VIEW C
(SHIFT TUBE)



CHECK FOR SHEARED INJECTED PLASTIC AT THESE LOCATIONS.

VIEW D
(STEERING SHAFT)



VIEW E
(METHOD TO DETERMINE COLUMN COLLAPSE) WITH LOWER BEARING REMOVED MEASURE DISTANCE BETWEEN ARROWS.

Figure 31 - Checking Steering Column for Accident Damage

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

(1) Steering Wheel-to-Shaft Nut	41.0 N·m (30 lb.ft.)
(9) Turn Signal Switch Connecting Screws	3.4 N·m (30 lb.in.)
(10) Turn Signal Switch Actuator Assembly Screw	2.3 N·m (20 lb.in.)
(15) Lock Housing Cover Screws	9.0 N·m (80 lb.in.)
(18) Lock Retaining Screw	2.5 N·m (22 lb.in.)
(61) Support-to-Lock Plate Screws	8.8 N·m (77 lb.in.)
(64) Shift Lever Gate Connecting Screws	3.7 N·m (33 lb.in.)
(78) Upper Ignition & Dimmer Switch Screw	4.0 N·m (35 lb.in.)
(79) Lower Dimmer Switch Nut	4.0 N·m (35 lb.in.)
(81) Dimmer & Ignition Switch Mounting Stud	4.0 N·m (35 lb.in.)
(84) Support Bracket Bolts	30.0 N·m (22 lb.ft.)
Lock Bolt Guard Screws	2.3 N·m (20 lb.in.)

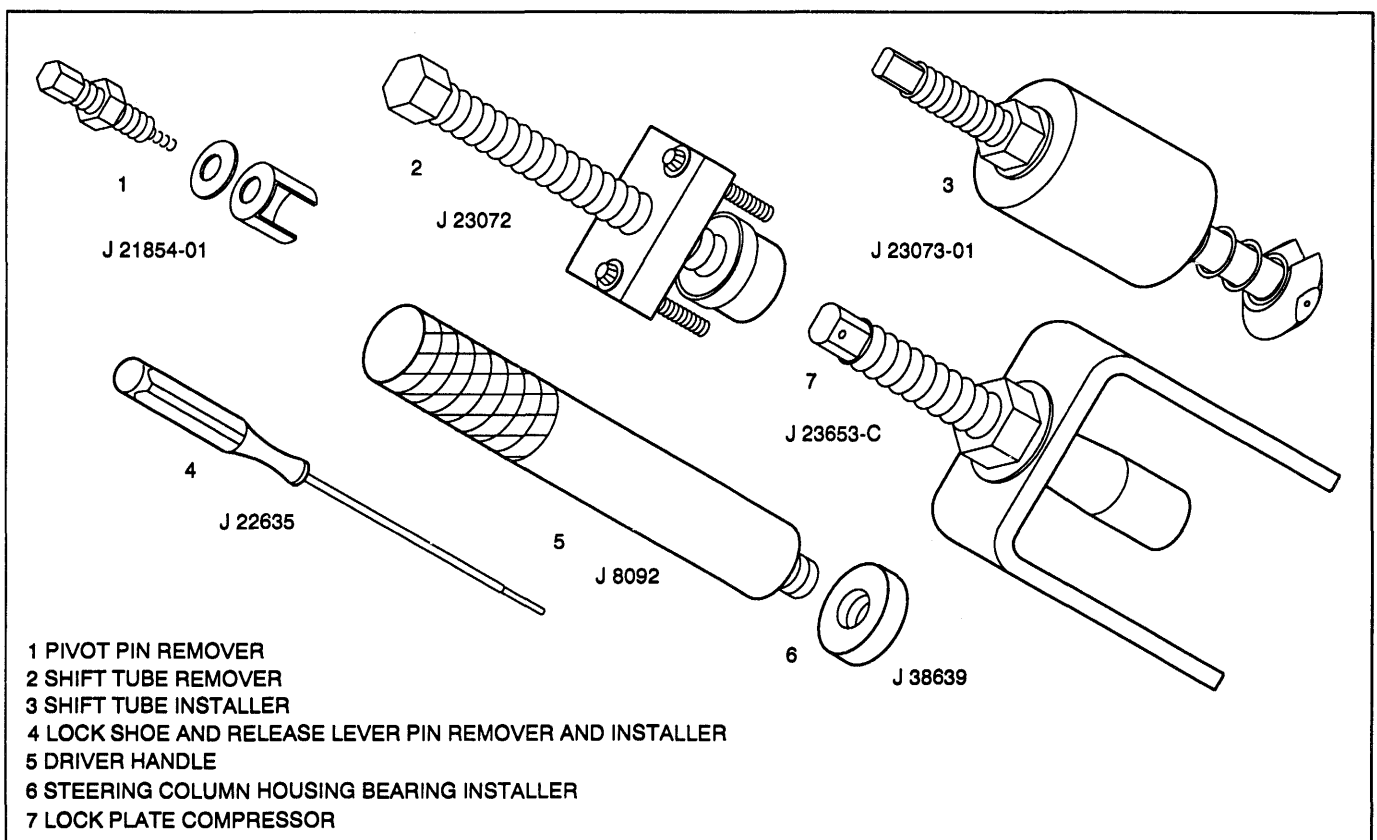


Figure 32 - Special Tools

SECTION 3F2B

TILT STEERING COLUMN FLOOR SHIFT UNIT REPAIR

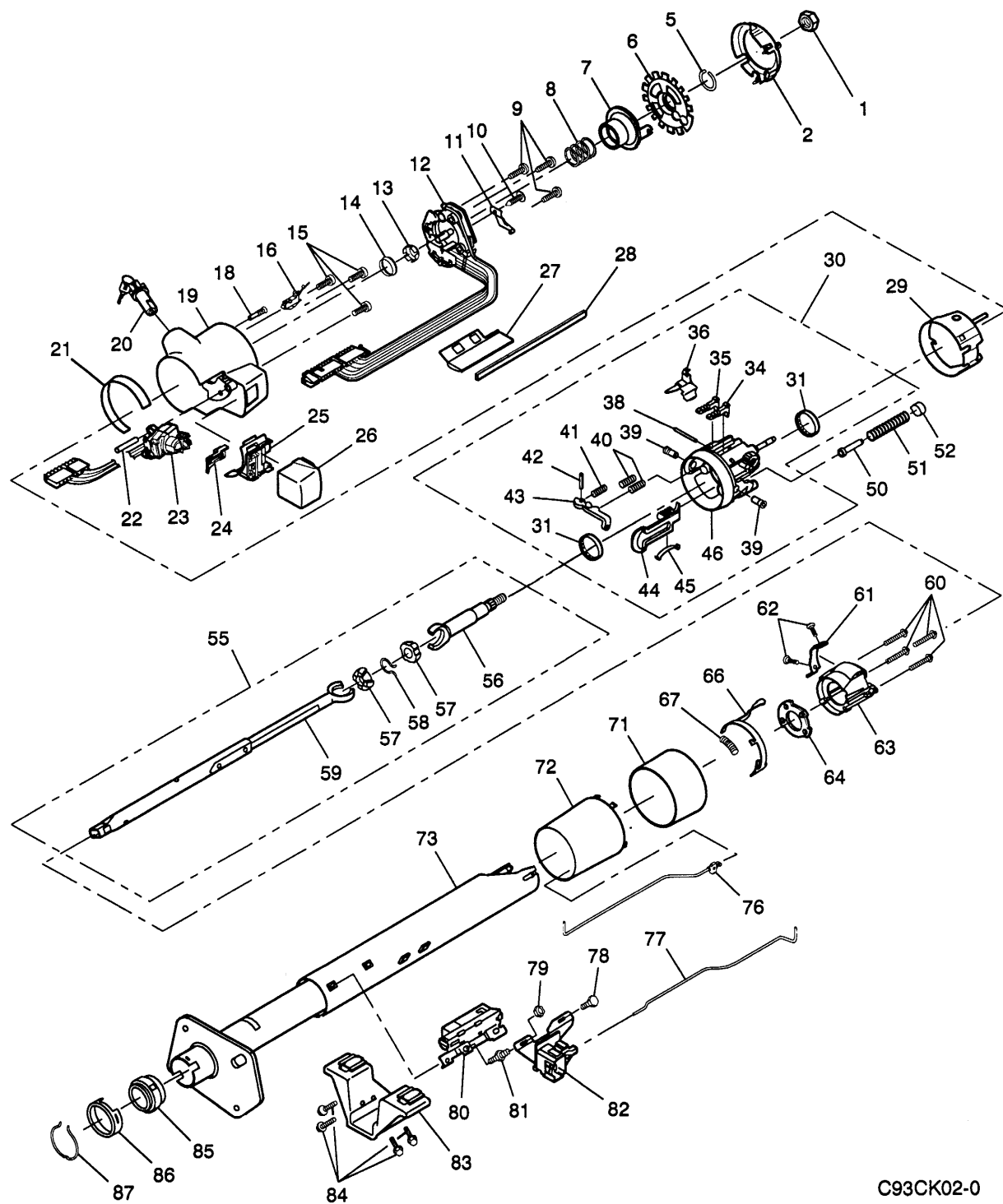
CAUTION: Before removing or installing any electrical unit or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "off" or "lock" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

Steering Column, Parts	3F2B-2	Switch Actuator Rack	
Sub Section A - Upper Column	3F2B-4	Bearing Assembly	
Shaft Lock		Steering Shaft Assembly	
Turn Signal Cancelling Cam Asm		Strg Column Housing Support Asm	
Upper Bearing Spring		Key Release Lever	
Upper Bearing Inner Race Seat		Sub Section D - Lower Column	3F2B-13
Inner Race		Dimmer Switch Assembly	
Turn Signal Switch Assembly		Dimmer Switch Adjustment	
Buzzer Switch Assembly		Ignition Switch Assembly	
Strg Col Lock Cylinder Set		Ignition Switch Adjustment	
Sub Section B - Housing Cover	3F2B-6	Adapter & Bearing Assembly	
Lock Housing Cover Assembly		Accident Damage	3F2B-16
Column Hsg Cover End Cap		Specifications	3F2B-16
Pivot & (Pulse) Switch Assembly		Fastener Tightening Specifications	3F2B-16
Dimmer Switch Rod Actuator		Special Tools	3F2B-17
Tilt Spring Assembly			
Sub Section C - Mid Column	3F2B-8		
Steering Column Housing Assembly			
Steering Wheel Lock Shoe			

3F2B-2 TILT STRG COL UNIT REPAIR (FLR SHFT)



C93CK02-0

Figure 1 - Tilt Steering Column

1- NUT, HEXAGON JAM	56- SHAFT ASM, RACE & UPPER
2- GUARD ASM, LOCK BOLT	57- SPHERE, CENTERING
5- RING, RETAINING	58- SPRING, JOINT PRELOAD
6- LOCK, SHAFT	59- SHAFT ASM, LOWER STEERING
7- CAM ASM, TURN SIG CANCEL	60- SCREW, SUPPORT
8- SPRING, UPPER BEARING	61- PLATE, SHROUD RETAINING
9- SCREW, BNDG HD CR RECESS	62- SCREW, OVL HD CROSS RECESS
10- SCREW, RD WASH HD (M4.2x1.41)	63- SUPPORT ASM, STRG COL HSG
11- ARM, SIGNAL SWITCH	64- PLATE, LOCK
12- SWITCH ASM, TURN SIGNAL	66- LEVER, KEY RELEASE
13- SEAT, UPPER BRG INNER RACE	67- SPRING, KEY RELEASE
14- RACE, INNER	71- BOWL, FLOOR SHIFT LEVER
15- SCREW, PAN HD SOC TAP	72- SHROUD, STRG COL HOUSING
16- SWITCH ASM, BUZZER	73- JACKET ASM, STRG COL
18- SCREW, LOCK RETAINING	76- ACTUATOR ASM, SWITCH
19- COVER ASM, LOCK HOUSING	77- ROD, DIMMER SWITCH
20- LOCK CYLINDER SET, STRG COL	78- SCREW, WASH HD (#10-24x.25)
21- RING, COVER TRIM	79- NUT, HEXAGON (#10-24)
22- PIN, SWITCH ACTUATOR PIVOT	80- SWITCH ASM, IGNITION
23- SWITCH ASM, PIVOT & (PULSE)	81- STUD, DIMMER & IGN SW MOUNTING
24- ACTUATOR, DIMMER SW ROD	82- SWITCH ASM, DIMMER
25- BASE PLATE, COL HSG COVER END	83- BRACKET ASM, STRG COL SUPT
26- CAP, COL HSG COVER END	84- BOLT, FLGD HEX HD (M8X1.25)
27- PROTECTOR, WIRING	85- BEARING ASM, ADAPTER &
28- PROTECTOR, WIRING	86- RETAINER, BEARING
29- COVER LINER ASM, PIN &	87- CLIP, LOWER BEARING ADAPTER
30- HOUSING ASM, STRG COLUMN	
31- BEARING ASM	
34- SHOE, STEERING WHEEL LOCK	
35- SHOE, STEERING WHEEL LOCK	
36- SHIELD, WIRE PROTECTOR	
38- PIN, DOWEL	
39- PIN, PIVOT	
40- SPRING, SHOE	
41- SPRING, RELEASE LEVER	
42- PIN, RELEASE LEVER	
43- LEVER, SHOE RELEASE	
44- RACK, SWITCH ACTUATOR	
45- SPRING, RACK PRELOAD	
46- HOUSING, STRG COLUMN	
50- GUIDE, SPRING	
51- SPRING, WHEEL TILT	
52- RETAINER, SPRING	
55- SHAFT ASM, STEERING	
	Service Kits
	201-SPRING SERV KIT, TILT COLUMN
	-INCLUDES: 13,14,39,50,51,52
	202-COVER & SCR SERV KIT, LOCK HSG
	-INCLUDES: 18,19
	203-SPHERE SERV KIT, TILT COLUMN
	-INCLUDES: 57,58
	204-GREASE SERV KIT, (SYNTHETIC)

Figure 2 - Tilt Steering Column - Legend

SUB SECTION A - UPPER COLUMN

INCLUDES:

SHAFT LOCK
TURN SIGNAL CANCELLING CAM ASM
UPPER BEARING SPRING
UPPER BEARING INNER RACE SEAT
INNER RACE
TURN SIGNAL SWITCH ASSEMBLY
BUZZER SWITCH ASSEMBLY
STRG COL LOCK CYLINDER SET

Tools Required:

J 23653-C Lock Plate Compressor

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

Remove or Disconnect

Figures 1 through 7

- Negative (-) battery cable.

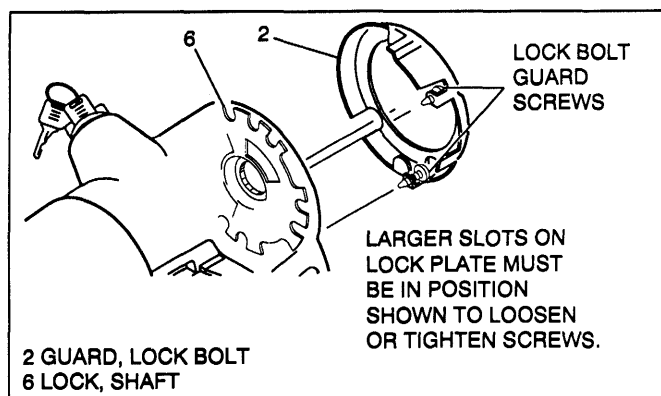


Figure 3 - Removing Lock Bolt Guard

- Lock bolt guard (2). (See Figure 3)
 - Place ignition switch to "RUN" position.
 - Rotate shaft (55) until block tooth is at 7 o'clock position and bolt guard screws are accessible through wide slots in shaft lock (6).

- Loosen screws on lock bolt guard (2) until guard can be removed. (Screws will be retained with lock bolt guard (2)).
- Place ignition switch to "LOCK" position.

- Shaft lock retaining ring (5) using J 23653-C to push down shaft lock (6).
 - Dispose of ring (5).

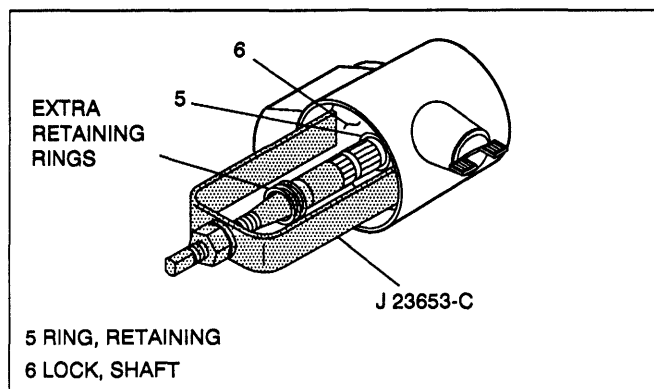


Figure 4 - Removing Shaft Lock Retaining Ring

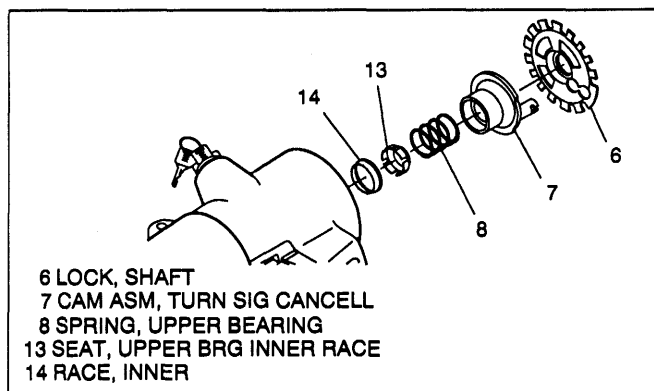


Figure 5 - Removing Components from Upper Shaft

- Shaft lock (6).
- Turn signal cancelling cam assembly (7).
- Upper bearing spring (8).
- Upper bearing inner race seat (13).
- Inner race (14).
- Turn signal to "RIGHT TURN" position (up).
- Multi-function lever and hazard knob assembly. (See Section 3F)
- Screw (10) and signal switch arm (11).
- Turn signal switch screws (9).

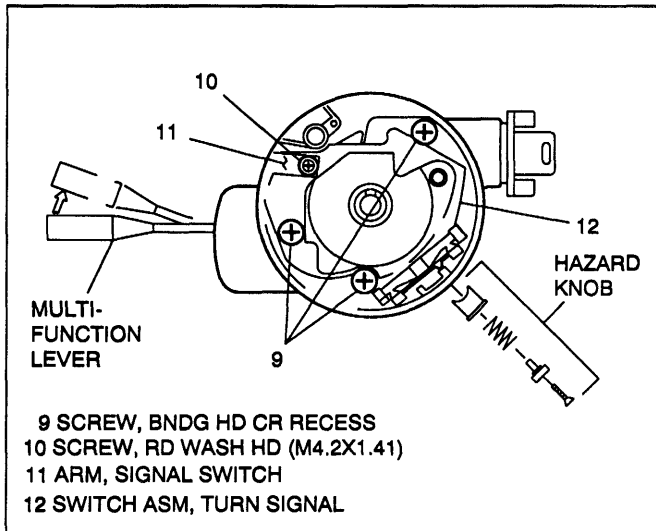


Figure 6 - Turn Signal Switch Removal Preparation

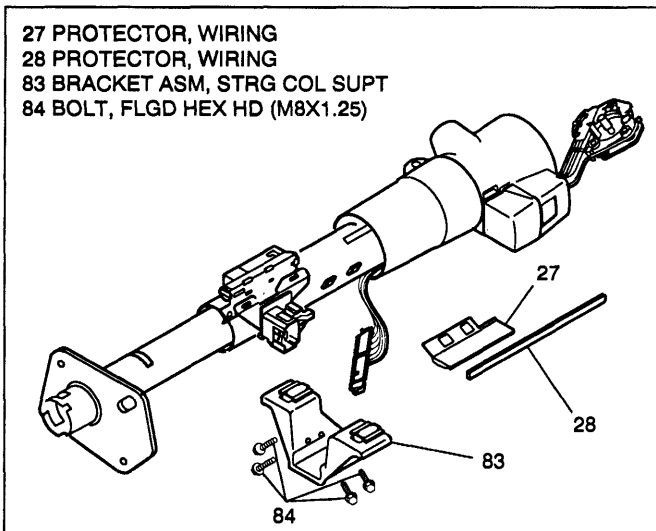


Figure 7 - Removing Turn Signal Switch

13. Turn signal switch assembly (12).
 - Let switch hang freely if removal is not needed.
 - To remove switch (12):
 - A. Hex head bolts (84).
 - B. Steering column support bracket assembly (83).
 - C. Turn signal switch connector from vehicle wire harness.
 - D. Wiring protectors (27) and (28).
 - E. Gently pull wire harness through column.
14. Key from steering column lock cylinder set (20).
15. Buzzer switch assembly (16).

16. Reinsert key in lock cylinder (20).
 - Key in "LOCK" position.
17. Lock retaining screw (18).
18. Lock cylinder (20).

Install or Connect
Figures 1,2 and 8

NOTICE: See "Notice" on page 3F2B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do may result in component damage or malfunctioning of steering column.

1. Lock cylinder (20).
2. Lock retaining screw (18).

Tighten

- Tighten screw (18) to 2.5 N·m (22 lb.in.).
3. Key from lock cylinder set (20).
 4. Buzzer switch assembly (16).
 5. Reinsert key in lock cylinder set (20).
 - Key in "LOCK" position.

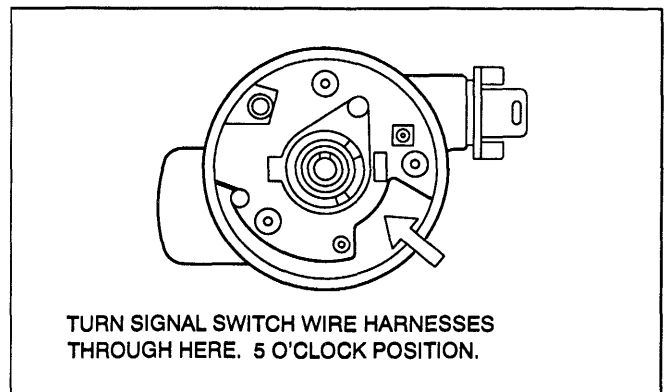


Figure 8 - Wire Harnesses through Column

6. Turn signal switch assembly (12) wire harness through steering column.
 - Let switch hang freely.
 - Switch connector to vehicle wire harness.

3F2B-6 TILT STRG COL UNIT REPAIR (FLR SHFT)

7. Turn signal switch assembly (12) and screws (9).

Tighten

- Tighten screws (9) to 3.4 N·m (30 lb.in.).

8. Signal switch arm (11) and screw (10).

Tighten

- Tighten screws (10) to 2.3 N·m (20 lb.in.).

9. Hazard knob assembly and multi-function lever.
(See Section 3F)
10. Inner race (14).
11. Upper bearing inner race seat (13).
12. Upper bearing spring (8).
13. Turn signal cancelling cam assembly (7).
 - Lubricate with grease, synthetic (service kit).
14. Shaft lock (6).
15. New shaft lock retaining ring (5) using J 23653-C to push down shaft lock (6).
 - Ring (5) must be firmly seated in groove on shaft.
16. Lock bolt guard (2). (See Figure 3)
 - A. Place ignition switch to "RUN" position.
 - B. Rotate shaft (55) until block tooth is at 7 o'clock position and bolt guard screw holes are accessible through wide slots in shaft lock (6).
 - C. Lock bolt guard (2) and tighten screws on guard until screw heads bottom out.

Tighten

- Tighten two bolts to 2.3 N·m (20 lb.in.).

Inspect

- Rotate shaft lock (6).
- Shaft lock (6) must not bind on guard screws or tabs on bolt guard (2).

NOTICE: Gently pull lower turn signal wires to remove any wire kinks that may be inside steering column assembly. Failure to do so may cause damage to wire harness.

17. Wiring protectors (27) and (28).
18. Support bracket (83).
19. Hex head bolts (84).

Tighten

- Tighten bolts (84) to 30.0 N·m (22 lb.ft.).
20. Refer to Section 3F to complete remaining steering column assembly.
 21. Negative (-) battery cable.

SUB SECTION B - HOUSING COVER

Figures 1 through 12

INCLUDES:

**LOCK HOUSING COVER ASSEMBLY
COLUMN HSG COVER END CAP
PIVOT & (PULSE) SWITCH ASSEMBLY
DIMMER SWITCH ROD ACTUATOR
TILT SPRING ASSEMBLY**

Tools Required:

J 23653-C Lock Plate Compressor

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

Important

- Remove only those components necessary to do repairs.

Remove or Disconnect

1. Do all steps, "Remove or Disconnect", Sub Section A.
2. Housing cover end cap (26).

3. Cover screws (15).
4. Tilt lever. (See Section 3F)
5. Lock housing cover assembly (19).
6. Base plate (25) and dimmer switch rod actuator (21).
7. Wire protector shield (36).
8. Switch actuator pivot pin (22).

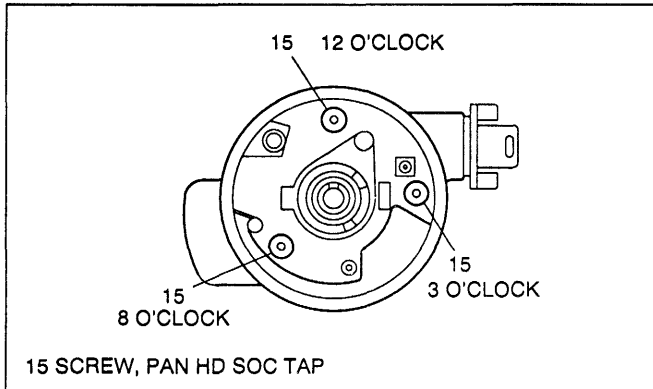


Figure 9 - Lock Housing Cover Screw Positions

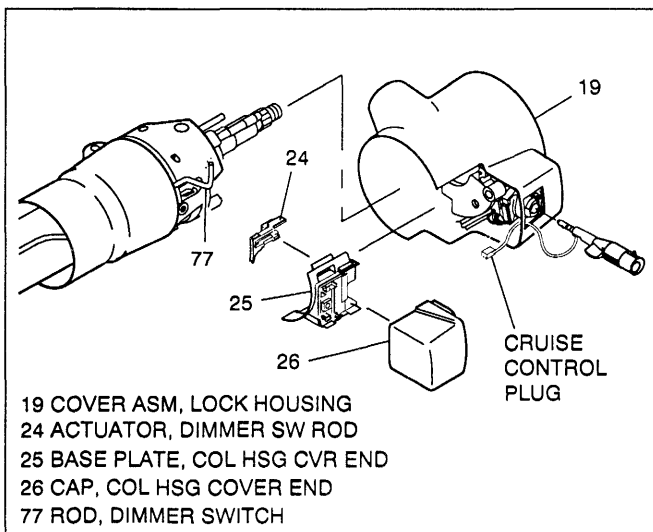


Figure 10 - Removing Lock Housing Cover

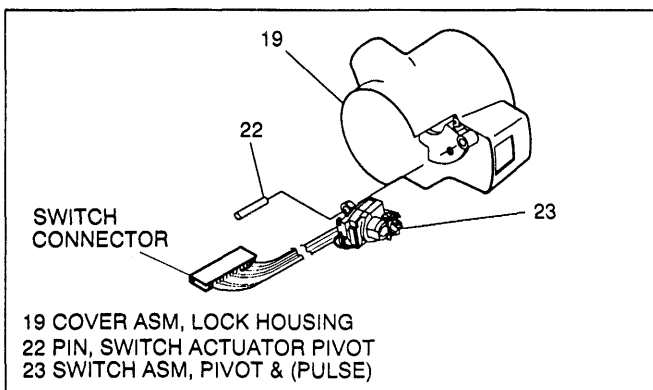


Figure 11 - Removing Pivot & (Pulse) Switch

9. Pivot & (pulse) switch assembly (23).
 - Let switch hang freely if removal is not needed.
 - To remove switch (23):
 - A. Pivot & (pulse) switch connector from vehicle wire harness.
 - B. Gently pull wire harness through column.
10. Pin & cover liner assembly (29).
11. Cover trim ring (21).
12. Spring retainer (52).
 - Using a cross recess head screwdriver, push retainer down and turn counterclockwise to release.
13. Spring (51) and spring guide (50).

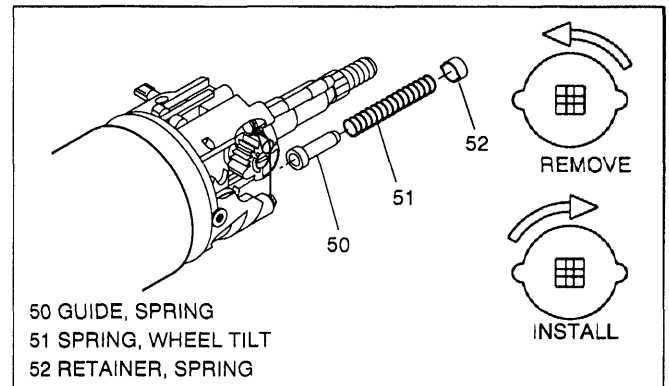


Figure 12 - Removing Tilt Spring Assembly

Install or Connect

NOTICE: See "Notice" on page 3F2B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Spring guide (50) and spring (51).
 - Lubricate with lithium grease.
2. Spring retainer (52).
 - Using a cross recess screwdriver push retainer down and turn clockwise to lock in place.
3. Cover trim ring (21).
4. Pin & cover liner assembly (29).

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5. Pivot & (pulse) switch assembly (23) to lock housing cover assembly (19).
6. Switch actuator pivot pin (22) to switch (23) and cover (19).
7. Pivot & (pulse) switch wire harness through steering column.
 - Switch connector to vehicle wire harness.
 - Wire protector shield (36).
8. Dimmer switch rod actuator (21) to base plate (25).
 - Lubricate with lithium grease.
9. Base plate (25) to lock housing cover assembly (19).
 - Bottom edge of dimmer switch rod actuator (24) should rest on bend in dimmer switch rod (77).
10. Lock housing cover assembly (19).
11. Screws (15). Tighten screw in 12 o'clock position first, screw in 8 o'clock position second, and screw in 3 o'clock position third.

Tighten

- Tighten screws (15) in same order to 9.0 N·m (80 lb.in.).
12. Install multi-function lever. (See Section 3F)
 13. Housing cover end cap (26).
 14. Do all steps, "Install or Connect", Sub Section A.

SUB SECTION C - MID COLUMN

Figures 1 through 24 and 26

INCLUDES:

STEERING COLUMN HOUSING ASM
STEERING WHEEL LOCK SHOE
SWITCH ACTUATOR RACK
BEARING ASSEMBLY
STEERING SHAFT ASSEMBLY
STEERING COL HSG SUPPORT ASM
KEY RELEASE LEVER

Tools Required:

- | | |
|------------|---|
| J 23653-C | Lock Plate Compressor |
| J 21854-01 | Pivot Pin Remover |
| J 22635 | Lock Shoe and Release Lever Pin Remover and Installer |
| J 8092 | Driver Handle |
| J 38639 | Strg Col Housing Bearing Installer |

Important

- Before doing any service procedures in this section, removal of Steering Wheel is needed. (Refer to service procedures in Section 3F)

Remove or Disconnect

1. Negative (-) battery cable.
2. Steering column from vehicle. (See Section 3F)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage. (See Figure 26)
3. Do all steps, "Remove or Disconnect", Sub Section B.

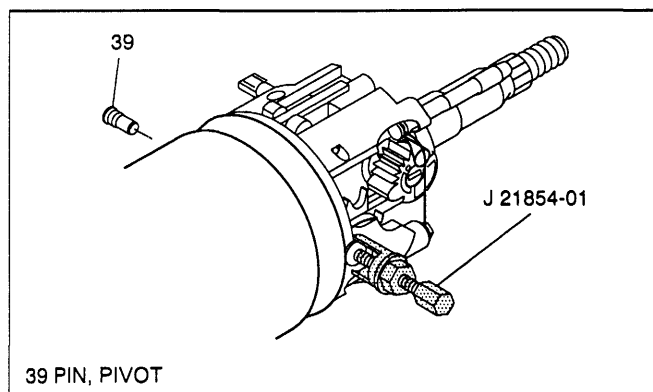


Figure 13 - Removing Pivot Pin

4. Pivot pins (39) using J 21854-01.
 - Reinstall tilt lever. (See Section 3F)
5. Steering column housing assembly (30).
 - Pull back on tilt lever and pull steering column housing assembly (30) down and away from column.

Important

- Remove only those components necessary to do repairs.

Disassemble

Steering Column Housing Assembly

- A. Bearing assembly (31).
- B. Switch actuator rack (44) and rack preload spring (45).
- C. Release lever pin (42) using J 22635.
- D. Shoe release lever (43).
- E. Release lever spring (41).
- F. Dowel pin (38) using J 22635.
- G. Lock shoes (34) and (35).
- H. Shoe springs (40).

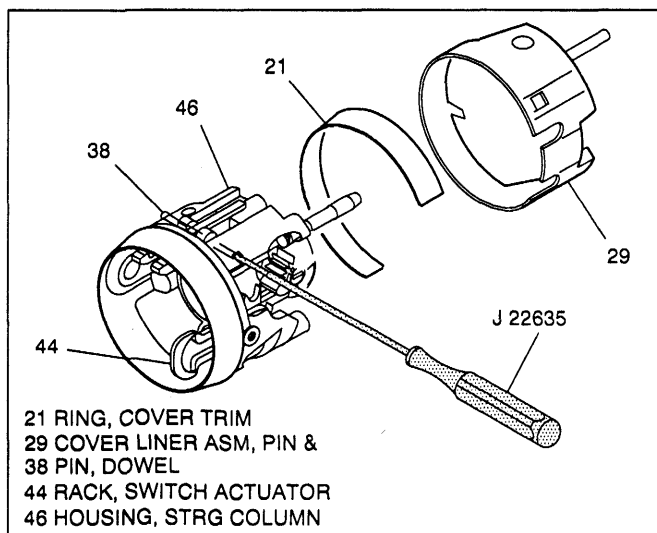


Figure 14 - Lock Housing Cover Components,
Exterior

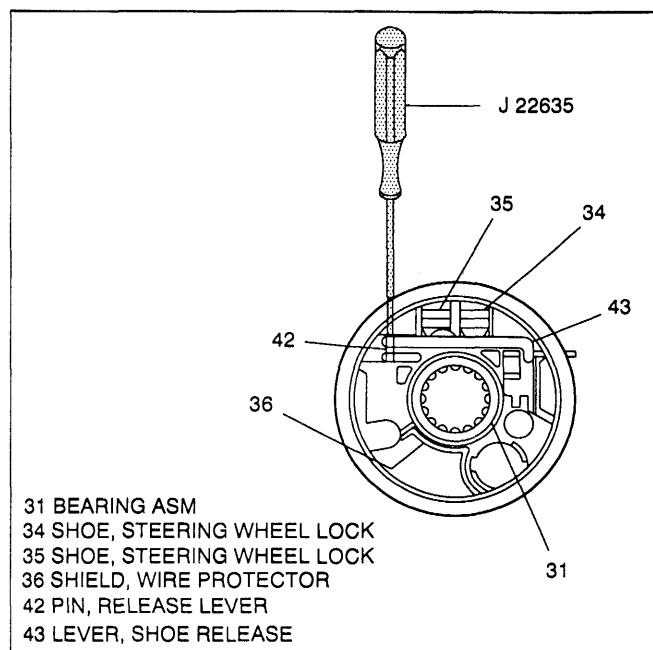


Figure 15 - Lock Housing Cover Components,
Interior

Assemble

Steering Column Housing Assembly

- A. Shoe springs (40).
 - B. Lock shoes (34) and (35).
 - C. Dowel pin (38) using J 22635.
 - D. Release lever spring (41).
 - E. Shoe release lever (43).
 - F. Release lever pin (42) using J 22635.
 - G. Rack preload spring (45).
 - H. Switch actuator rack (44) to actuator sector.
 - I. Bearing assembly (31) lubricated with lithium grease to column housing (46) using J 38639 and J 8092.
6. Lower bearing adapter clip (87).
 7. Bearing adapter retainer (86).
 8. Adapter & bearing assembly (85).
 9. Steering column shaft assembly (55).

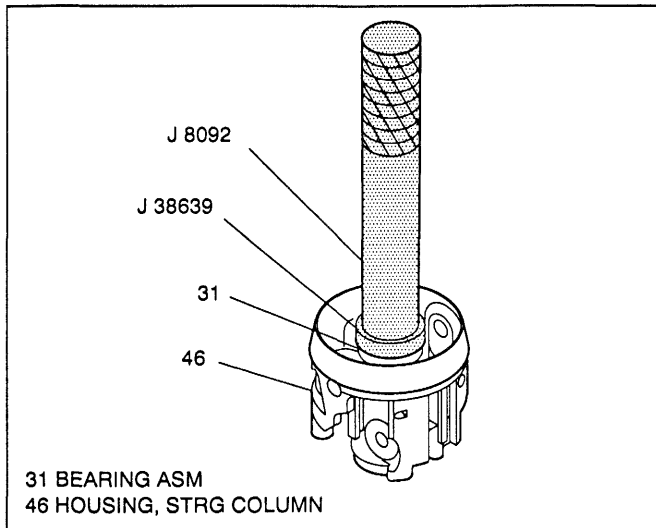


Figure 16 - Installing Bearings

Inspect

- Steering column shaft assembly (55) for accident damage. (See Figure 26)

Important

- Mark upper shaft assembly (56) and lower steering shaft assembly (59) to ensure proper assembly. Failure to assemble properly will cause steering wheel to be turned 180 degrees. (See Figures 17 and 18)

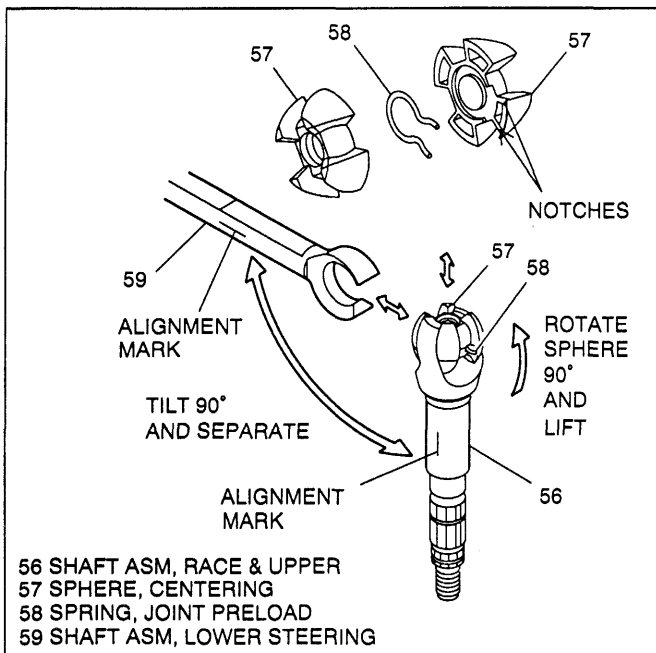


Figure 17 - Removing Steering Shaft Components

Important

- Remove only those components necessary to do repairs.

Disassemble

Steering Column Shaft Assembly

- Upper shaft assembly (56), lower steering shaft assembly (59).
 - Tilt 90 degrees to each other and disengage.
- Centering sphere (57) from upper shaft assembly (56).
 - Rotate sphere 90 degrees and slip out.
- Joint preload spring (58) from centering sphere (57).

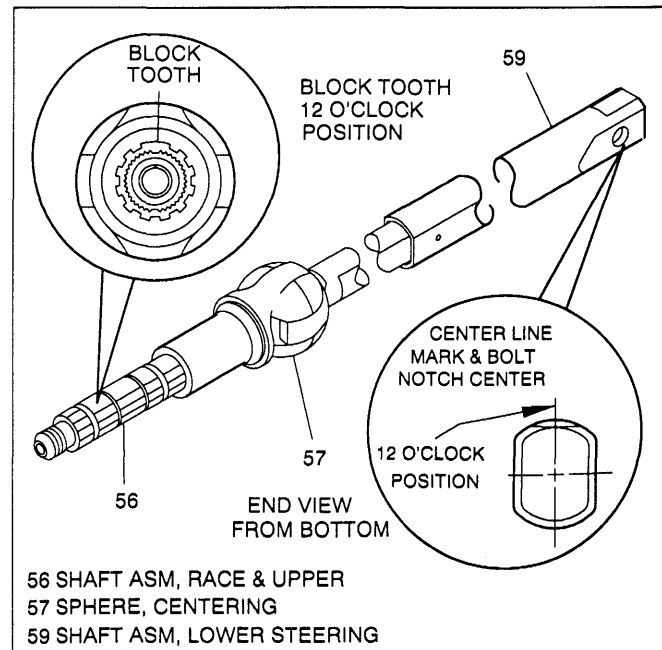


Figure 18 - Correct Upper to Lower Shaft Orientation

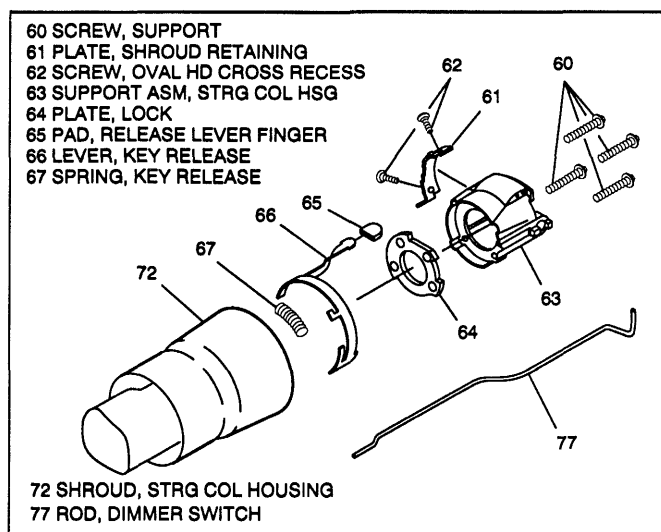


Figure 19 - Removing Column Housing Support

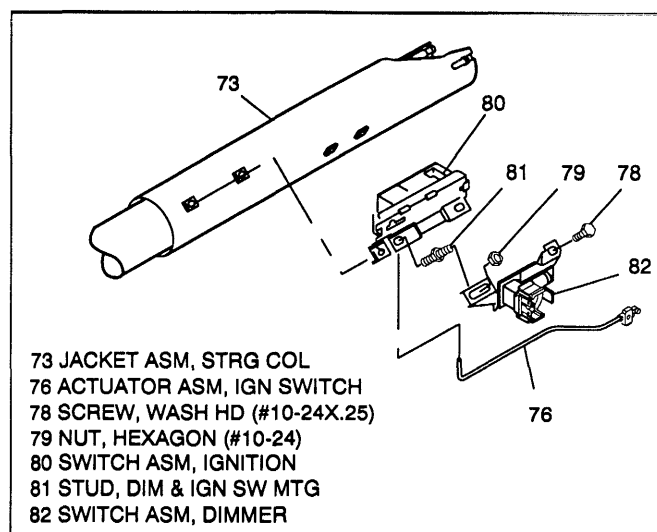


Figure 20 - Removing Ignition and Dimmer Switches

Assemble

Steering Column Shaft Assembly

- A. Joint preload spring (58) to two centering sphere (57).
 - B. Centering sphere (57).
 - Lubricate with lithium grease, slip into upper shaft assembly (56), and rotate sphere 90 degrees.
 - C. Upper shaft assembly (56) to lower steering shaft assembly (59).
 - Line up marks and tilt assemblies 90 degrees to each other.
10. Support screws (60).
 11. Column housing support assembly (63) with dimmer switch rod (77) from steering column jacket assembly (73).
 - Rod (77) from support (63).
 - Two cross recess screws (62) and shroud retaining plate (61).
 12. Lock plate (64).
 13. Key release lever (66) with key release spring (67) from floor shift lever bowl (71).
 - Spring (67) from lever (66).
 14. Steering column housing shroud (72) and bowl (71).
 - Bowl (71) from shroud (72).

15. Hexagon nut (79) and washer head screw (78).
16. Dimmer switch assembly (82).
17. Dimmer & ignition switch mounting stud (81).
18. Ignition switch assembly (80) with switch actuator assembly (76).
 - Switch actuator assembly (76) from switch assembly (80).

Install or Connect

NOTICE: See "Notice" on page 3F2B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Bowl (71) to shroud (72).
2. Shroud (72) with bowl (71) to jacket (73).
3. Key release spring (67) to lever (66).
4. Key release lever (66) with spring (67) to floor shift lever bowl (71).
5. Dimmer switch rod (77) to column housing support assembly (62).
 - Shroud retaining plate (61).
 - Two screws (62).

Tighten

- Tighten screws (62) to 3.7 N·m (33 lb.in.).

- Support assembly (63) and screws (60).

Tighten

- Tighten screw (60) to 8.8 N·m (77 lb.in.).

- Actuator assembly (76) to groove in housing support assembly (63).
- Column shaft assembly (55) to jacket assembly (73).
 - Lubricate with lithium grease.
- Tilt lever. (See Section 3F)
- Steering column housing assembly (30) to column.
 - Position column housing (30) and align switch actuator rack (44) with pin on end of ignition switch actuator assembly (76).
 - Pull back on tilt lever, pushing column housing assembly (30) onto column housing support assembly (63).
 - Release tilt lever to lock shoes (34) and (35) onto dowel pins.
 - Remove tilt lever. (See Section 3F)
- Pivot pins (39).
 - Lubricate with lithium grease.
 - Press pin until firmly seated, two places.
- Adapter & bearing assembly (85).
 - Lubricate inner surface of bearing (85) with lithium grease.

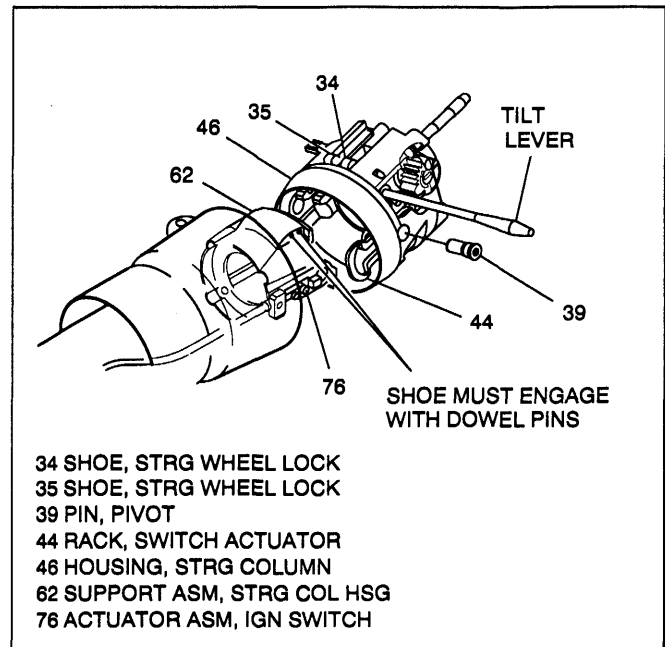


Figure 21 - Installing Column Housing to Housing Support

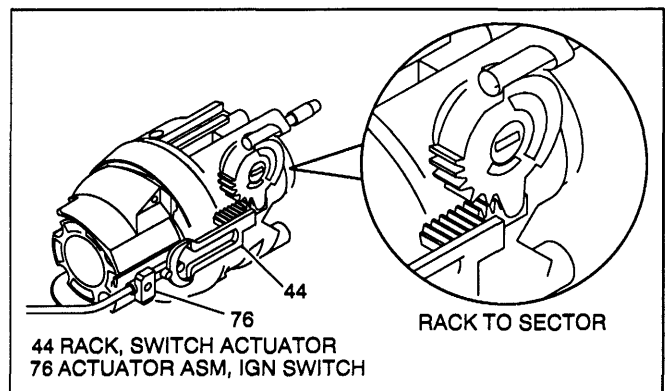


Figure 22 - Actuator Assembly to Actuator Rack Installed

- Bearing adapter retainer (86).
- Lower bearing adapter clip (87).
- Do steps 1 through 13, "Install or Connect", Sub Section B.
- Do steps 1 through 20, "Install or Connect", Sub Section A.
- Do all steps, Ignition switch assembly, "Install or Connect", Sub Section D.

SUB SECTION D - LOWER COLUMN

INCLUDES:

**DIMMER SWITCH ASSEMBLY
 DIMMER SWITCH ADJUSTMENT
 IGNITION SWITCH ASSEMBLY
 IGNITION SWITCH ADJUSTMENT
 ADAPTER & BEARING ASSEMBLY**

Dimmer Switch Assembly

↔ Remove or Disconnect
Figures 1,2 and 20

1. Negative (-) battery cable.
2. Washer head screw (78).
3. Hexagon nut (79).
4. Dimmer switch assembly (82).
 - Dimmer switch (82) from vehicle wire harness.

→→ Install or Connect
Figures 1,2,20 and 23

NOTICE: See "Notice" on page 3F2B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Dimmer switch assembly (82) to rod (77).
2. Hex nut (79) and washer head screw (78).
 - Tighten finger tight.

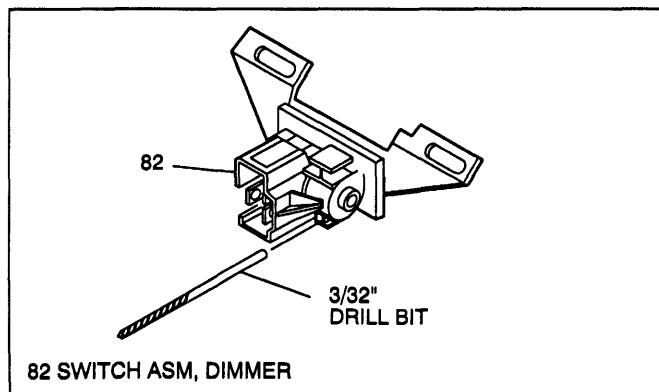


Figure 23 - Adjusting Dimmer Switch

🔧 Adjust

- Dimmer switch (82). (See Figure 23)
 - A. Place 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod (77) to remove all lash.
 - C. Remove drill bit.

🔩 Tighten

- Tighten screw (78) and nut (79) to 4.0 N·m (35 lb.in.).
3. Vehicle wire harness to dimmer switch (82).
 4. Negative (-) battery cable.

Ignition Switch Assembly

↔ Remove or Disconnect
Figures 1,2 and 20

1. Negative (-) battery cable.
2. Washer head screw (78).
3. Hexagon nut (79).
4. Dimmer switch assembly (82) from rod (77).
5. Dimmer & ignition switch mounting stud (81).
6. Ignition switch assembly (80) from ignition switch actuator assembly (76).
 - Ignition switch (80) from vehicle wire harness.

→→ Install or Connect
Figures 1,2,20,23 and 24

NOTICE: See "Notice" on page 3F2B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Lock cylinder (20) to "OFF-LOCK" position.

3F2B-14 TILT STRG COL UNIT REPAIR (FLR SHFT)

NOTICE: Install ignition switch (80) to jacket (73) with switch in "OFF-LOCK" position. (See Figure 24) New ignition switch will be pinned in "OFF-LOCK" position. Remove plastic pin after switch is assembled to column. Failure to do so may cause switch damage.

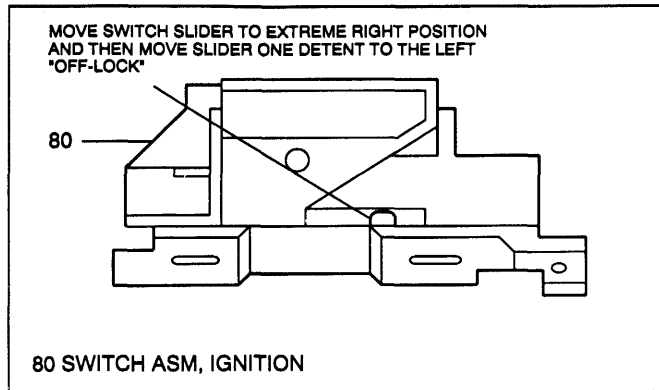


Figure 24 - Adjusting Ignition Switch

Adjust

- Ignition switch assembly (80). (See Figure 24)
 - A. Move switch slider to extreme right position.
 - B. Move switch slider one detent to left "OFF-LOCK" position.

2. Ignition switch assembly (80) and mounting stud (81).

Tighten

- Tighten stud (81) to 4.0 N·m (35 lb.in.).
3. Dimmer switch assembly (82).
 4. Hex nut (79) and washer head screw (78).
 - Tighten finger tight.

Adjust

- Dimmer switch (82). (See Figure 23)
 - A. Place 3/32-inch drill bit in hole on switch to limit travel.
 - B. Position switch on column and push against dimmer switch rod (77) to remove all lash.
 - C. Remove drill bit.

Tighten

- Tighten nut (79) and screw (78) to 4.0 N·m (35 lb.in.).
5. Vehicle wire harness to ignition switch (80) and dimmer switch (82).
 6. Negative (-) battery cable.

Adapter & Bearing Assembly Figures 1,2,25 and 26

Remove or Disconnect

1. Negative (-) battery cable.
2. Steering column from vehicle. (See Section 3F)

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping steering column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on steering column assembly could cause jacket to bend or deform. Any of the above damage could impair steering column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain steering column rigidity.

Inspect

- Steering column for accident damage. (See Figure 26)

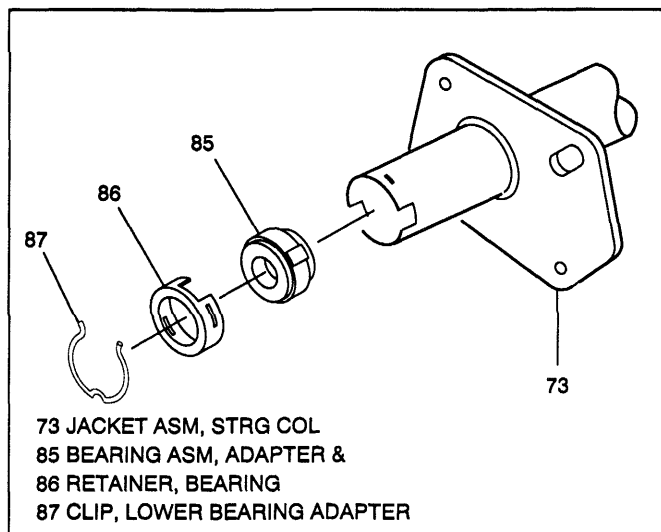


Figure 25 - Removing Adapter & Bearing Assembly

3. Lower bearing adapter clip (87).
4. Bearing adapter retainer (86).
5. Adapter & bearing assembly (85).

Install or Connect

NOTICE: See "Notice" on page 3F2B-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Adapter & bearing assembly (85).
 - Lubricate inner surface of bearing (85) with lithium grease.
2. Bearing adapter retainer (86).
3. Lower bearing adapter clip (87).
4. Steering column to vehicle. (See Section 3F)
5. Negative (-) battery cable.

CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

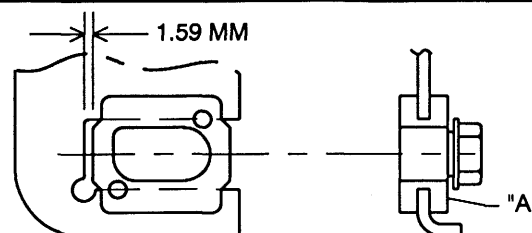
NOTICE: Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, or where the steering column has been impacted may also have a damaged or misaligned steering column.

CHECKING PROCEDURE**JACKET ASM, STEERING COLUMN**

- Check capsules on steering column bracket assembly; all should be within 1.59mm from the bottom of the slots (View A). If not, bracket should be replaced if bracket is bolted to the jacket assembly or the jacket assembly should be replaced if bracket is welded to jacket assembly.
- Check contact surface "A" on capsules (View B). The bolt head must not contact surface "A" or shear load would be increased. If contact is made, replace bracket assembly or jacket assembly.
- Check for jacket assembly collapse by measuring the distance from the lower edge of upper jacket to a defined point on the lower jacket (View D). If measured dimensions are not within specifications, a new jacket must be installed.

STEERING SHAFT ASM

- Visually inspect steering shaft for sheared injected plastic (View C). If steering shaft shows sheared plastic, a new steering shaft must be installed.
- Any frame damage that could cause a bent steering shaft must have steering shaft runout checked in the following manner: Using a dial indicator at lower end of steering shaft, have steering wheel rotated. Runout must not exceed 1.59mm.

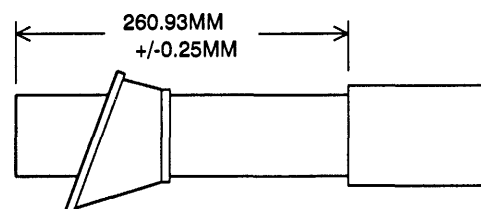
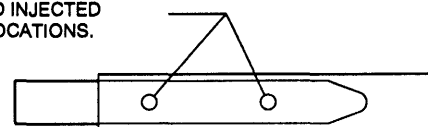
**VIEW A****(CAPSULES)****VIEW B**

CAPSULES MUST BE WITHIN 1.59 MM FROM BOTTOM OF SLOTS;
IF NOT, REPLACE BRACKET OR JACKET.

THE BOLT HEAD MUST NOT CONTACT SURFACE "A". IF CONTACT IS MADE, THE CAPSULE SHEAR LOAD WILL BE INCREASED. REPLACE BRACKET OR JACKET.

CHECK FOR SHEARED INJECTED PLASTIC AT THESE LOCATIONS.

VIEW C
(STEERING SHAFT)

**VIEW D**

(METHOD TO DETERMINE COLUMN COLLAPSE)
WITH LOWER BEARING REMOVED
MEASURE DISTANCE BETWEEN ARROWS.

Figure 26 - Checking Steering Column for Accident Damage

SPECIFICATIONS**FASTENER TIGHTENING SPECIFICATIONS**

(1) Steering Wheel-to-Shaft Nut	41.0 N·m (30 lb.ft.)
(9) Turn Signal Switch Connecting Screws	3.4 N·m (30 lb.in.)
(10) Turn Signal Switch Actuator Assembly Screw	2.3 N·m (20 lb.in.)
(15) Lock Housing Cover Screws	9.0 N·m (80 lb.in.)
(18) Lock Retaining Screw	2.5 N·m (22 lb.in.)
(60) Support-to-Jacket Screws	8.8 N·m (77 lb.in.)
(62) Shroud Retaining Plate Screws	3.7 N·m (33 lb.in.)
(78) Upper Ignition & Dimmer Switch Screw	4.0 N·m (35 lb.in.)
(79) Lower Dimmer Switch Nut	4.0 N·m (35 lb.in.)
(81) Dimmer & Ignition Switch Mounting Stud	4.0 N·m (35 lb.in.)
(84) Support Bracket to Jacket Bolts	30.0 N·m (22 lb.ft.)
Lock Bolt Guard Screws	2.3 N·m (20 lb.in.)

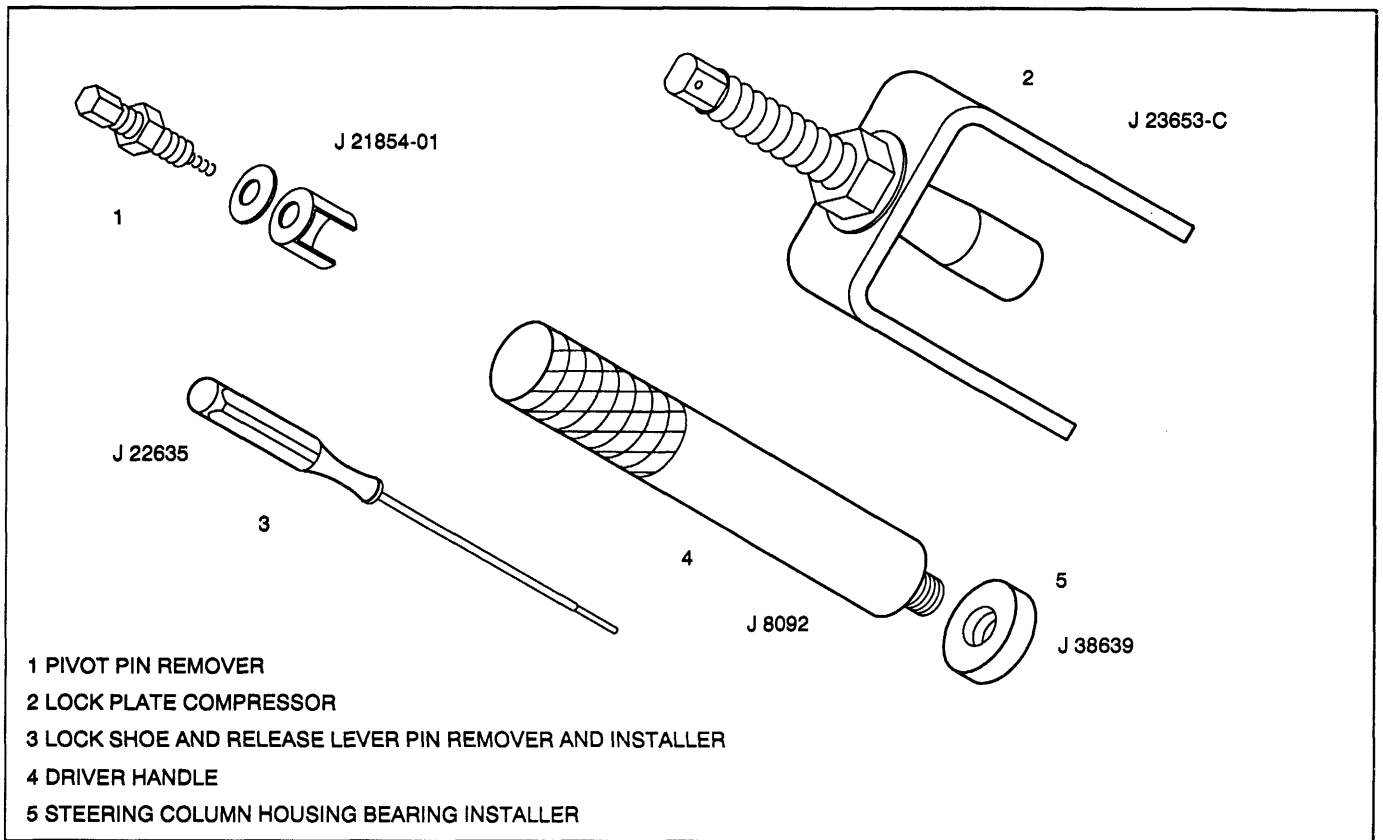


Figure 27 - Special Tools

SECTION 4

PROPELLER SHAFT AND AXLES

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Rear Axle.....	4B1-1
Front Driving Axle.....	4C-1

SECTION 4A

PROPELLER SHAFT

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

PROPELLER SHAFT

Torque is transmitted from the transmission to the rear axle through one or more propeller shafts. The number of propeller shafts vary with the vehicle wheel base and combination of transmission, transfer case, (front drive), and rear axle equipment (figure 1). Propeller shafts have universal joints at each end to accommodate angle variations between the transmission and rear axle, and rear axle position caused by suspension motion. All propeller shafts are the balanced tubular type. The driveline is connected to the transmission with a splined slip joint (normal for a one-piece propeller shaft) (figure 2) or a fixed yoke, normal for a two-piece and three-piece propeller shafts (figure 3). If two or

more propeller shafts are used on a vehicle, a center bearing is used. The center bearing is usually located near the rear of the front propeller shaft, and the slip joint is usually at the forward end of the rear propeller shaft.

PHASING

The propeller shaft is designed and built with the yoke lugs (ears) in line with each other. This design produces the smoothest running shaft possible, and is known as "in phase" (figures 1 and 4).

An out of phase propeller shaft can cause vibration. The propeller shaft will generate vibration from speeding up and slowing down each time the universal joint

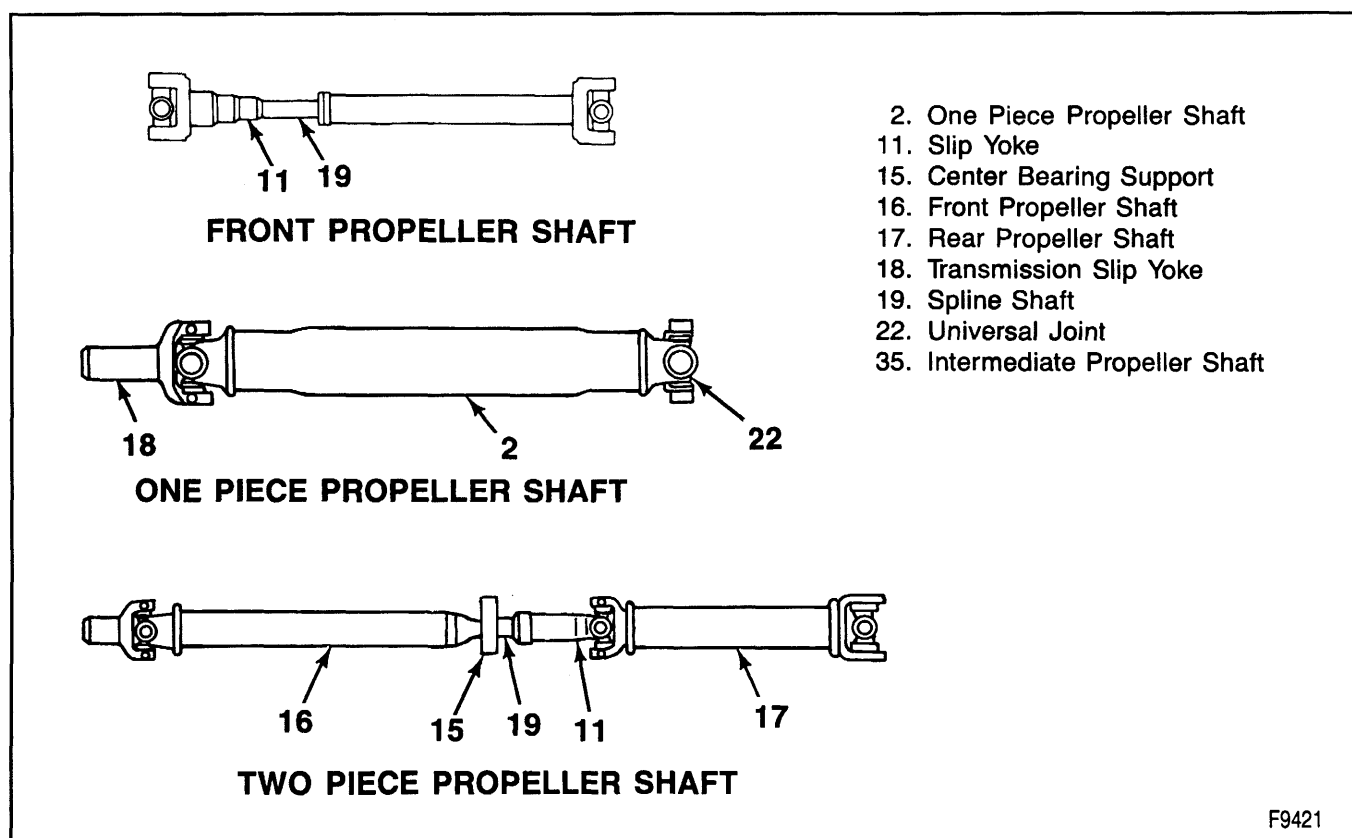


Figure 1—Propeller Shafts

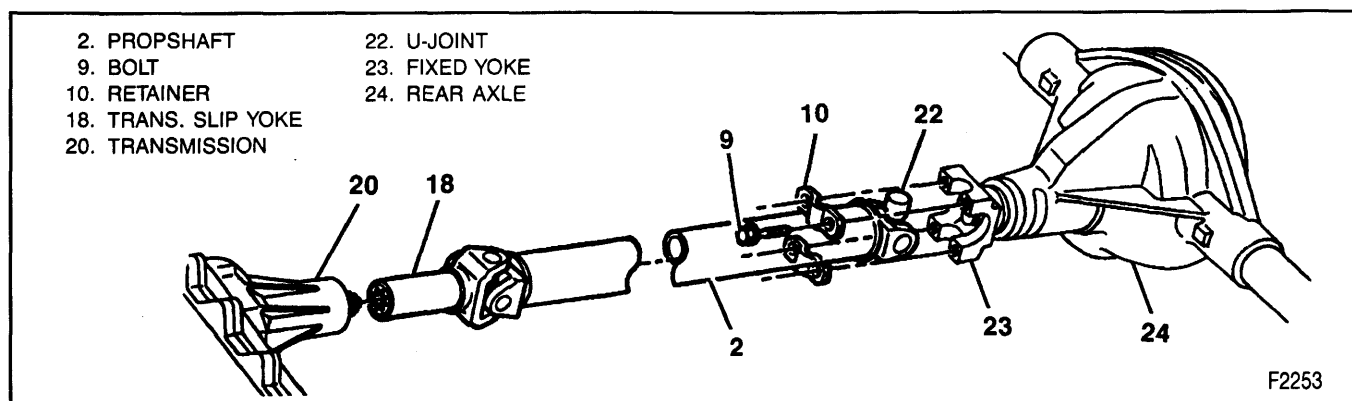


Figure 2—Transmission Slip Yoke

goes around. This vibration would be the same as a person snapping a rope and watching the "wave" reaction flow to the end. An in phase propeller shaft would be similar to two persons snapping a rope at the same time, and watching the "waves" meet and cancel each other out. A total cancellation of vibration produces a smooth flow of power in the driveline. Since phasing of a propeller shaft is between the center universal joints, it is very important to reference mark the front and rear propeller shafts before removal to ensure proper phasing upon reinstallation. Some splined shaft slip yokes are keyed to ensure proper phasing.

CENTER BEARING

Center bearings support the driveline when two or more propeller shafts are used. The center bearing is a ball bearing mounted in a rubber cushion that is attached to a frame crossmember. The bearing is prelubricated and sealed by the manufacturer. The cushion allows vertical motion at the driveline and helps isolate the vehicle from vibration.

UNIVERSAL JOINT

Universal joints (figure 5) are designed to handle the effects of various loadings and rear axle windup during acceleration and braking. Within the designed angle variations, the universal joint will operate efficiently and safely. When the design angle is changed or exceeded, the operational life of the joint may decrease.

The trunnion bearings used in universal joints are the needle roller type. The needle rollers are held in place on the trunnions by round bearing cups. The bearing cups are held in the yokes by either snap rings or injected plastic.

The OEM universal joints are lubricated for life and cannot be lubricated on the vehicle. A service kit which

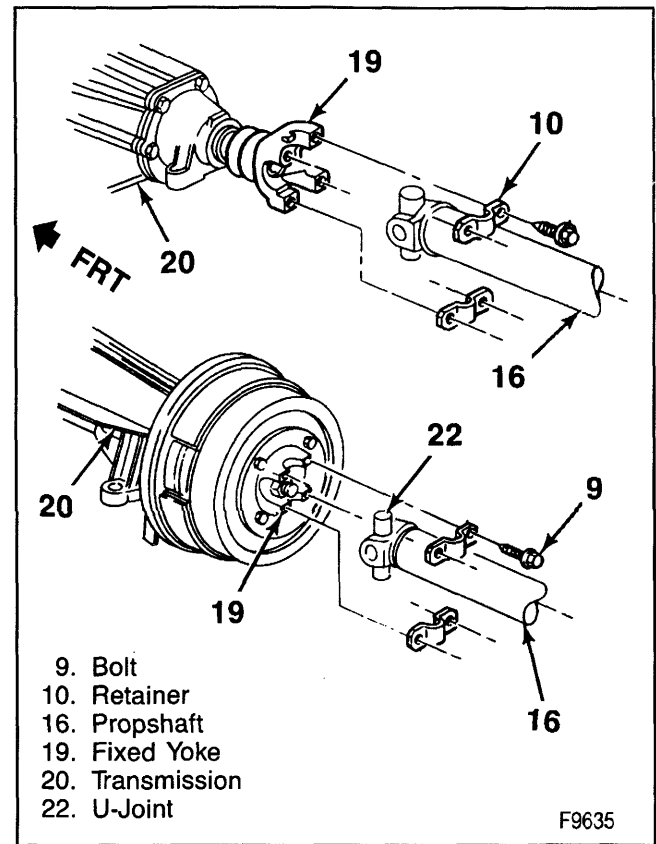


Figure 3—Fixed Yoke Companion Flange

consists of a spider with bearing assemblies and snap rings may be installed if a universal joint becomes worn or noisy. If it becomes necessary to repair a universal joint, the propeller shaft must be removed from the vehicle. Take care to avoid jamming, bending, or over-angulating any parts of the propeller shaft assembly.

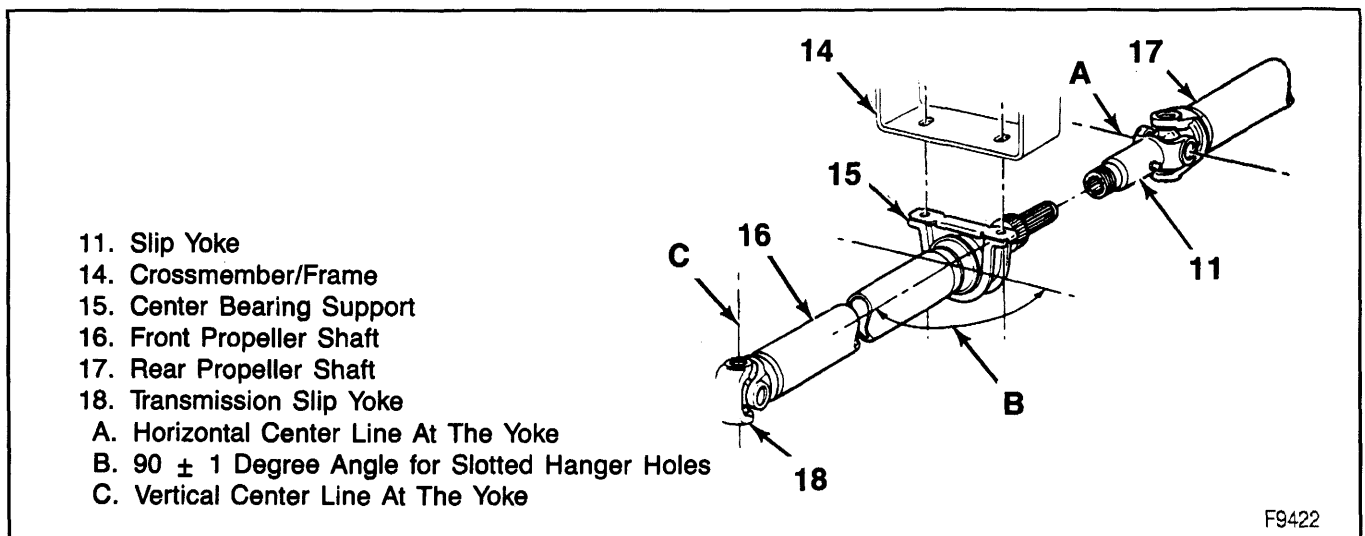


Figure 4—Propeller Shaft Assembly in Phase

4A-4 PROPELLER SHAFT

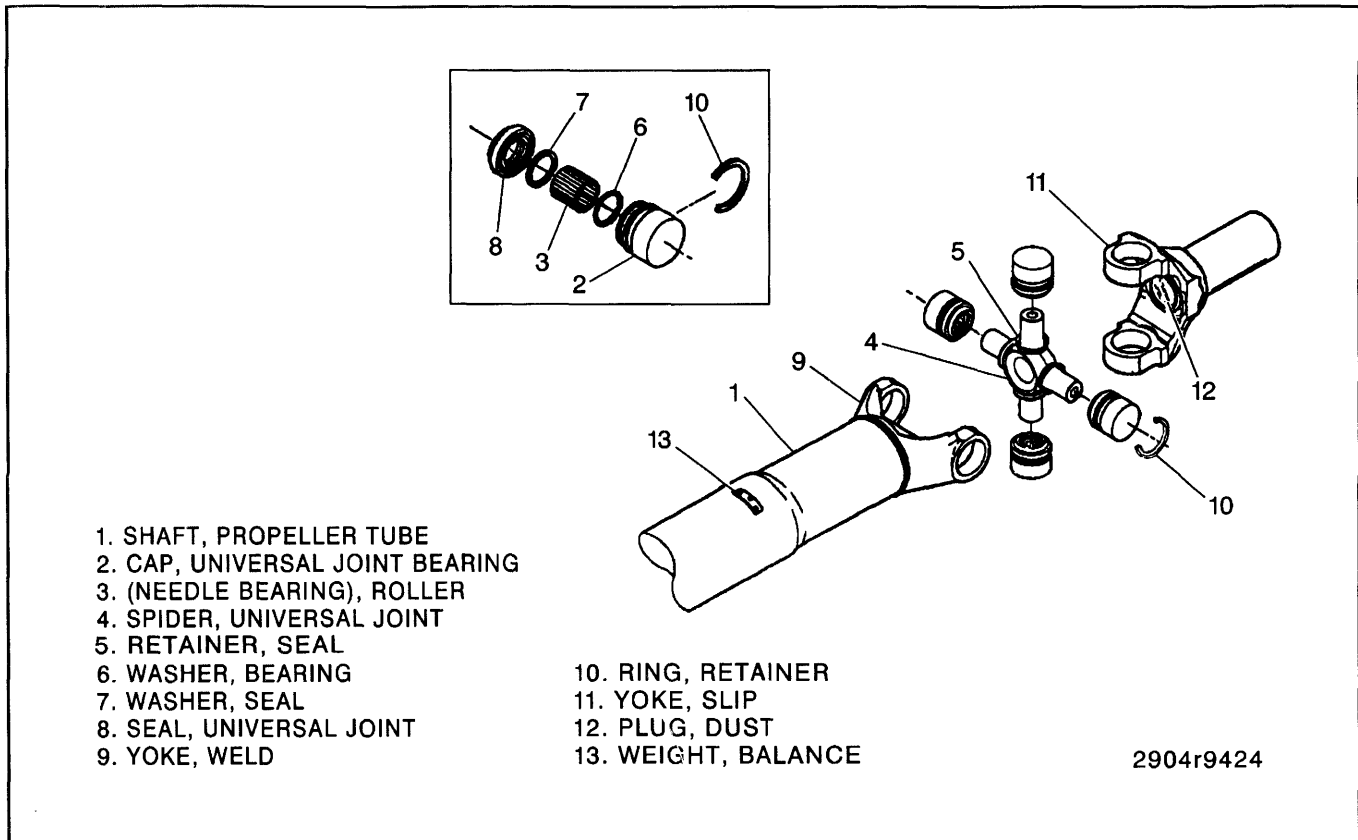


Figure 5—Universal Joint Components

DIAGNOSIS OF PROPELLER SHAFT AND UNIVERSAL JOINT

PROBLEM	POSSIBLE CAUSE	CORRECTION
Leak at the Front Slip Yoke. (An Occasional Drop of Lubricant Leaking from the Splined Yoke is Normal and Requires No Attention)	1. Slip yoke barrel burred, nicked, or worn. 2. Defective transmission rear oil seal.	1. Replace the seal. Minor burrs can be smoothed by careful use of crocus cloth or fine stone honing. Replace the yoke if badly burred. 2. Replace the transmission rear oil seal and replenish the transmission oil.
Ping, Snap, or Click in Drive Line (Usually Heard on Initial Load after the Transmission is in Gear; Forward or Reverse)	1. Loose bushing bolts on the rear springs or upper and lower control arms. 2. Loose fixed yoke or companion flange. 3. Worn or damaged universal joints.	1. Tighten the bolts to specified torque. 2. Tighten the bolts and pinion nut to specified torque. 3. Replace universal joints.
Knocking or Clunking Noise in the Driveline when Operating the Vehicle in High Gear or coasting in Neutral at 16 km/h (10 MPH).	1. Worn or damaged universal joint. 2. Side gear hub counterbore in the differential is worn oversize.	1. Replace the worn or damaged universal joint. 2. Replace the differential case and/or the sidegears.

DIAGNOSIS OF PROPELLER SHAFT AND UNIVERSAL JOINT (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Roughness or Vibration	1. Bent or dented propeller shaft. 2. Undercoating on propeller shaft. 3. Tire unbalance, 48-80 km/h (30-50 mph). 4. Tight universal joints. 5. Worn universal joints. 6. Bent companion flange or flange with excessive runout. 7. Burrs or gouges on companion flange. Check snap ring locating surfaces on flange yoke. 8. Propeller shaft, parking brake drum, or companion flange is unbalanced. 9. Incorrect rear joint angle. The angle is usually too large when it is a factor. 10. Excessive looseness at the slip spline. 11. Distorted or damaged yokes or flanges. 12. Yokes out of phase on two-piece prop-shaft system. 13. Driveline vibration at 80 km/h (50 mph).	1. Replace propeller shaft. 2. Clean propeller shaft. 3. Balance or replace as required. 4. On snap ring retainer U-joints, tap the yokes with a hammer to free up. If unable to free up or if joint feels rough, replace joint. 5. Replace. 6. Refer to SECTION 0C. 7. Deburr or replace the companion flange. 8. Check for a missing balance weight on all three components. Rotate the propeller shaft in the companion flange 180 degrees. 9. Check and correct trim height at curb weight. Check and correct joint angle. Refer to SECTION 0C. 10. Replace necessary parts. 11. Install new yokes or flanges. 12. Re-index propeller shaft. 13. Check propeller shaft runout and for missing balance weights. Refer to propeller shaft runout check.
Scraping Noise	Pinion flange, or center bearing rubbing.	Correct the interference.
Roughness Above 56 km/h (35 MPH) Felt and/or Heard	Tires unbalanced or worn.	Balance or replace as required.
Squeak	1. Lack of lubricant. 2. Center bearing.	1. Replace universal joints as required. 2. Replace as required.
Whine or Whistle	Center support bearing.	Replace center support bearing.
Shudder on Acceleration (Low Speed)	1. Loose or missing bolts at the center bearing or flanges. 2. Incorrectly set or excessive joint angle. 3. Worn universal joint. 4. Worn center bearing support cushion.	1. Replace or tighten bolts to specified torque. 2. Shim under the transmission support mount to change the joint angle. #1254001 std. shim. On two piece prop-shaft, shim center bearing support to reduce center joint angle. 3. Replace. 4. Replace center bearing. NOTE: Some vertical movement is normal.

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ON-VEHICLE SERVICE

PROPELLER SHAFT BALANCE CHECK

Important

- Never vent or fill the propeller shaft with an aerosol foam product. This will cause an excessive imbalance condition.
- Raise the vehicle on a hoist so the wheels can spin.

Important

- In order to get an accurate check it is necessary to lift the vehicle by the axle or suspension to duplicate actual conditions. By doing this the pinion angle will be as close as possible to normal.

Remove or Disconnect (Figure 1)

1. Tire and wheel assemblies and the brake drums.

Inspect

- Propeller shaft, universal joints, and attachments for mud, undercoating, or loose fasteners.

Clean

- Propeller shaft, universal joints, and attachments.

Tighten

- Any loose attachments or fasteners.

CAUTION: Never run the vehicle higher than 89 km/h (55 mph). All persons should stay clear of universal joints and balance weight areas to avoid possible injury. Do not run the vehicle on the hoist for extended periods due to the danger of overheating the transmission or engine.

Measure

- Run the vehicle in gear at the speed where the disturbance peaks; observe the intensity of the disturbance. Refer to SECTION 0C.

CAUTION: Do not apply the brakes with the drums removed. System damage or personal injury may result.

2. Bolts from rear of pinion flange.
3. Retainers.
4. Propeller shaft.
 - Rotate the propeller shaft 180 degrees from the original position.

Install or Connect

1. Propeller shaft.
2. Retainers.

NOTICE: Refer to "Notice" on page 4A-1.

3. Bolts into rear pinion flange.

Tighten

- Bolts to 20 N.m (15 lbs. ft.).
 - Determine the position which gives the best balance.
4. Rear drums and wheel and tire.
 - Determine the position which gives the best driveline response by road testing the vehicle for a final check of the propeller shaft balance.
 - If unacceptable balance/vibration, continue with "Propeller Shaft Runout Check" later in this section.

PROPELLER SHAFT RUNOUT CHECK

Noise or vibration at high speed could be caused by a bent propeller shaft. The propeller shaft could have been damaged by rough handling or a collision. Check for propeller shaft straightness.

1. Raise the vehicle on a hoist so the wheels can spin.
2. Attach a dial indicator having a magnetic base to a smooth place on the vehicle underbody.
3. Take dial indicator readings at the propeller shaft check points (figures 6 and 7).

PROPELLER SHAFT	FRONT CHECK	CENTER CHECK	REAR CHECK
One Piece	0.040"	0.050"	0.055"
Aluminum Graphite	0.040"		0.040"
Two Piece Driveshaft:			
With Slip Yoke	0.025"		0.004"*
With Fixed Yoke	0.040"		0.007"*
Two Piece Rear	0.030"†	0.040"	0.040"
Three Piece Driveshaft:			
Full Size Pick-up	0.025"	0.040"	0.040"
Suburban	0.015"	0.010"	0.015"
*NOTE: This measurement must be taken on the ground surface near the spline, with the rear propeller shaft removed.			

PROPELLER SHAFT	FRONT CHECK	CENTER CHECK	REAR CHECK
†NOTE: This measurement must be taken with the rear propeller shaft mounted on the front shaft which is within specifications.			
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Figure 6—Propeller Shaft Runout Specifications

! Important

- Do not attach the dial indicator base at a weld.
 - The indicator base must not rock.
4. With the transmission in neutral, hand rotate one wheel or the axle pinion flange or the transmission yoke and take the necessary dial indicator readings on the propeller shaft. Record the readings. On models having a two-piece driveline, measure the rear propeller shaft runout (figure 7).
 5. Reference mark the position of the rear propeller shaft yoke to the pinion flange, then remove the rear propeller shaft and measure the front propeller shaft runout on the tube and at the specified location on the splined shaft end (figure 7).
 6. If the runout exceeds specification, rotate the propeller shaft 180 degrees at the companion flange and install. Check the runout.
 7. If the propeller shaft runout is over specification, check for a damaged companion flange. Refer to SECTION 0C.
 8. If the runout is still over specification at one or more check points, replace the propeller shaft after checking for vibration or noise (figure 6).

- Check the runout on the replacement propeller shaft.

! Important

- The splined end of the front propeller shaft is critical to the smooth operation of a two-piece driveline. Be sure the dial indicator readings are accurate.

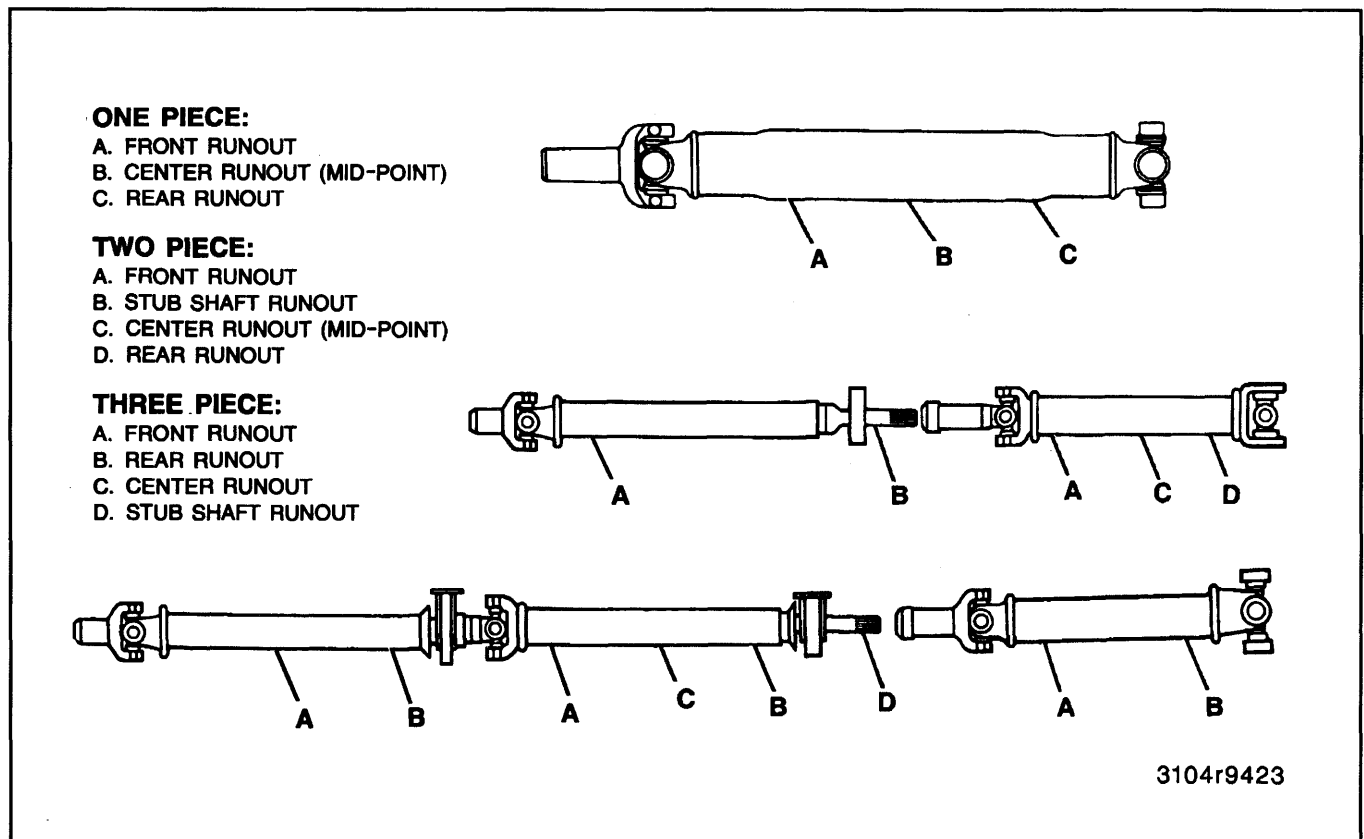
REAR PROPELLER SHAFT REPLACEMENT (REAR DRIVE)

↔ Remove or Disconnect (Figures 8 and 9)

- Raise vehicle on a hoist.
1. Skid plate if used.
 - Reference mark the propeller shaft to pinion flange connection.
 - Reference mark slip yoke to transmission for proper reassembly
 - For two-piece Saginaw propeller shaft, unscrew threaded cap on center slip yoke. (figure 9).
 - For two-piece Dana propeller shaft, pull the stub shaft out of the slip yoke. (figure 10).

! Important

- When servicing driveshafts with the pop on seal, do not remove the seal from the sleeve.



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Figure 7—Propeller Shaft Runout Check Points

4A-8 PROPELLER SHAFT

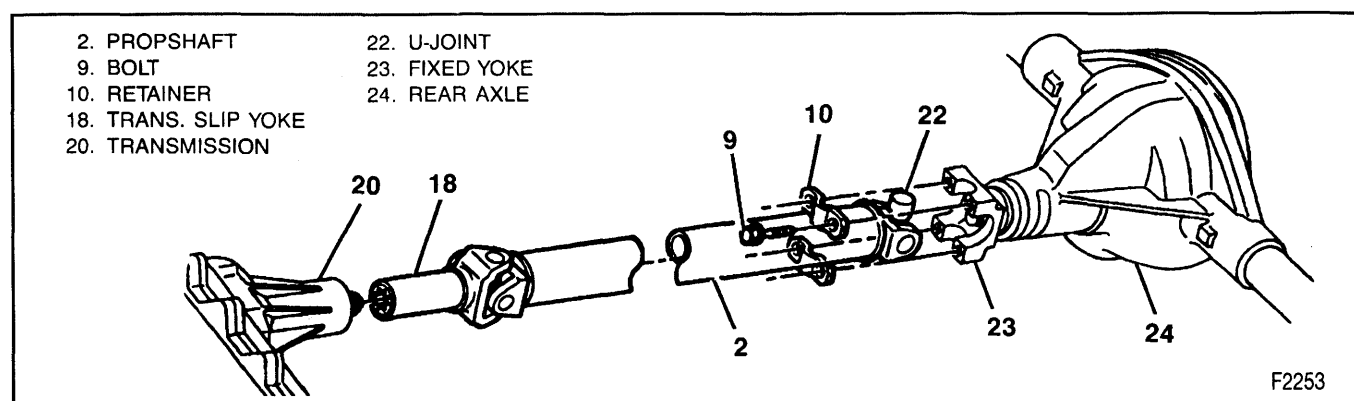


Figure 8—One-Piece Propeller Shaft

Removal of the seal causes damage to the seal lip where it contacts the sleeve yoke. If removal of the seal is necessary, it should be replaced with a new unit.

2. Bolts.
3. Retainers.

! Important

- Do not pound on the propeller shaft yoke ears. The injection joints may fracture. Never pry or place any tool between a yoke and a universal joint.
4. Yoke and cross assembly.
 - Tape bearing cups to prevent the loss of bearing rollers
 5. Propeller shaft.
 - Slide the propeller shaft forward.
 - Lower the propeller shaft and remove.
 - Do not allow the universal joint to incline greatly; the joint may fracture.
 6. Center bearing support.
 7. Front propeller shaft.
 - Always support the propeller shaft.
 - Do not allow the universal joint to bend deeply as the universal joint could fracture.
 - Remove the propeller shaft with a rearward movement.

🧼 Clean

- All parts with an approved solvent.

👁 Inspect

1. Outer diameter of transmission yoke for burrs. Any burring will damage the transmission seal.
2. For proper installation and uniform seating of bearing cups.
3. Slip yoke splines for wear.
4. For twisted slip yoke splines or possibly the wrong universal joint.
5. Universal joint bearings for wear. Replace as necessary.

↔ Install or Connect

ONE-PIECE PROPELLER SHAFT (Figure 8)

1. Propeller shaft into the transmission.
 - Lubricate slip joint spline with chassis grease.
2. Align the reference marks on the pinion flange and the propeller shaft rear yoke.
3. Yoke and cross assembly onto the fixed yoke.
4. Retainers.

NOTICE: Refer to "Notice" on page 4A-1.

5. Bolts.

🔧 Tighten

- Bolt to 20 N·m (15 lbs. ft.).

TWO-PIECE PROPELLER SHAFT (Figure 1)

1. Propeller shaft into the transmission.
 - Be sure the slip joint splines are lubricated.
 - Bottom the propeller shaft yoke in the transmission.
2. Center bearing support.
 - Align the center bearing support 90 degrees to the propeller shaft center lines (figure 4).

NOTICE: Refer to "Notice" on page 4A-1.

3. Center bearing support bolts.

🔧 Tighten

- Center bearing support bolts to 35 N·m (25 lbs. ft.).

! Important

- Set the transmission yoke ears in a vertical position for proper phasing.
 - Locate the bridged tooth (B) on the splined shaft (figure 9).
4. Slip yoke onto the splined shaft.
 - Mate the missing tooth in the yoke with the bridged tooth on the splined shaft (figure 9).
 - Support the propeller shaft.
 - Be sure the slip yoke ears are horizontal.
 5. Propeller shaft.
 - Align reference marks.
 6. Retainers.

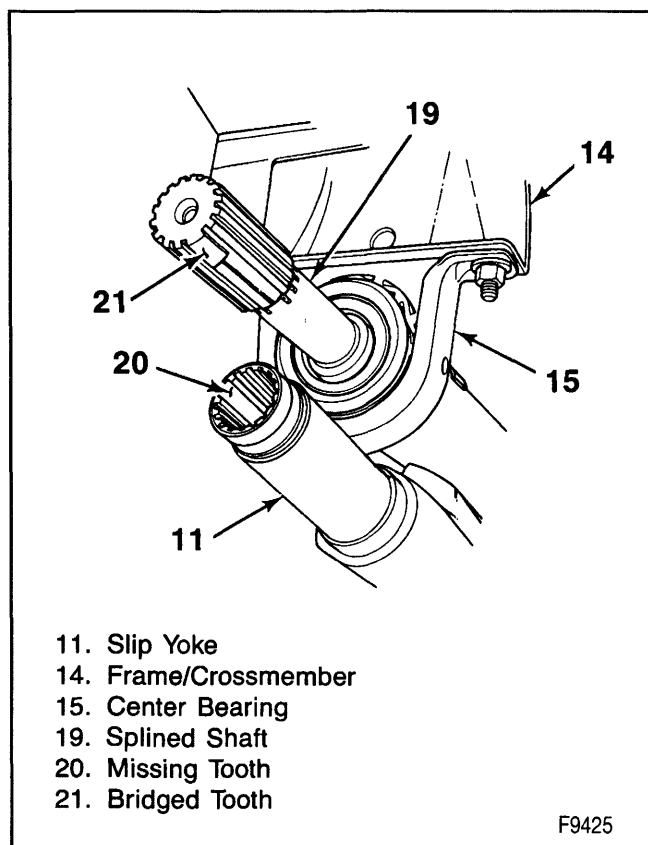


Figure 9—Splined Shaft Indexing (Saginaw)

NOTICE: Refer to "Notice" on page 4A-1.

7. Bolts.



Tighten

- Bolts to 20 N·m (15 lbs. ft.).

8. Skid plate

- Check for proper joint fit.
- Lubricate the slip yoke.
- Lubricate the center slip joint on two-piece shaft.

THREE-PIECE PROPELLER SHAFT



Remove or Disconnect (Figures 4 and 11).

- Raise the vehicle on a hoist.
 - Reference mark the rear propeller shaft to pinion flange connection.
 - Support the rear propeller shaft.
1. Bolts from pinion flange.
 2. Retainers.
 3. Yoke and universal joint assembly from pinion flange



Important

- Do not pound on the original propeller shaft yoke ears. The plastic injection joints may fracture. Never pry or place any tool between a yoke and a universal joint.
- Tape bearing cups onto yoke to prevent the loss of bearing rollers.

4. Rear propeller shaft.

- Slide the rear propeller shaft forward.
- Lower the rear propeller shaft and withdraw under the rear axle.
- Do not allow the universal joint assembly to incline greatly. The joint may fracture.
- Reference mark the intermediate propeller shaft to front propeller shaft yoke.
- Support the intermediate propeller shaft.

5. Bolts from front propeller shaft yoke at front center bearing support.

6. Retainers.

7. Nuts from intermediate shaft center bearing support.

8. Bolts and washers.

9. Intermediate propeller shaft center bearing support from hanger.

10. Yoke and universal joint assembly from front propeller shaft rear yoke.



Important

- Do not pound on the original propeller shaft yoke ears. The plastic injection joints may fracture. Never pry or place any tool between a yoke and a universal joint.
- Tape bearing cups onto yoke to prevent the loss of bearing rollers.

11. Intermediate propeller shaft.

- Reference mark the front propeller shaft to the yoke or parking brake drum.
- Support the front propeller shaft.

12. Bolts and retainers from yoke.

13. Nuts from front propeller shaft center bearing support.

14. Bolts and washers.

15. Front propeller shaft center bearing support from hanger.

16. Universal joint assembly from transmission yoke.



Important

- Do not pound on the original propeller shaft yoke ears. The plastic injection joints may fracture. Never pry or place any tool between a yoke and a universal joint.
- Tape bearing cups onto yoke to prevent the loss of bearing rollers.

17. Front propeller shaft.



Clean

- All parts with an approved solvent.



Inspect

1. For proper installation and uniform seating of all universal joint bearing cups.
2. Intermediate propeller shaft to rear propeller shaft slip yoke splines for twisting or wear.
3. Inside of rear propeller shaft slip yoke for spline twisting or wear.
4. Front and rear center bearing support rubber insulators for deterioration or separation from the support framework.
5. Propeller shaft assemblies for damage.

4A-10 PROPELLER SHAFT

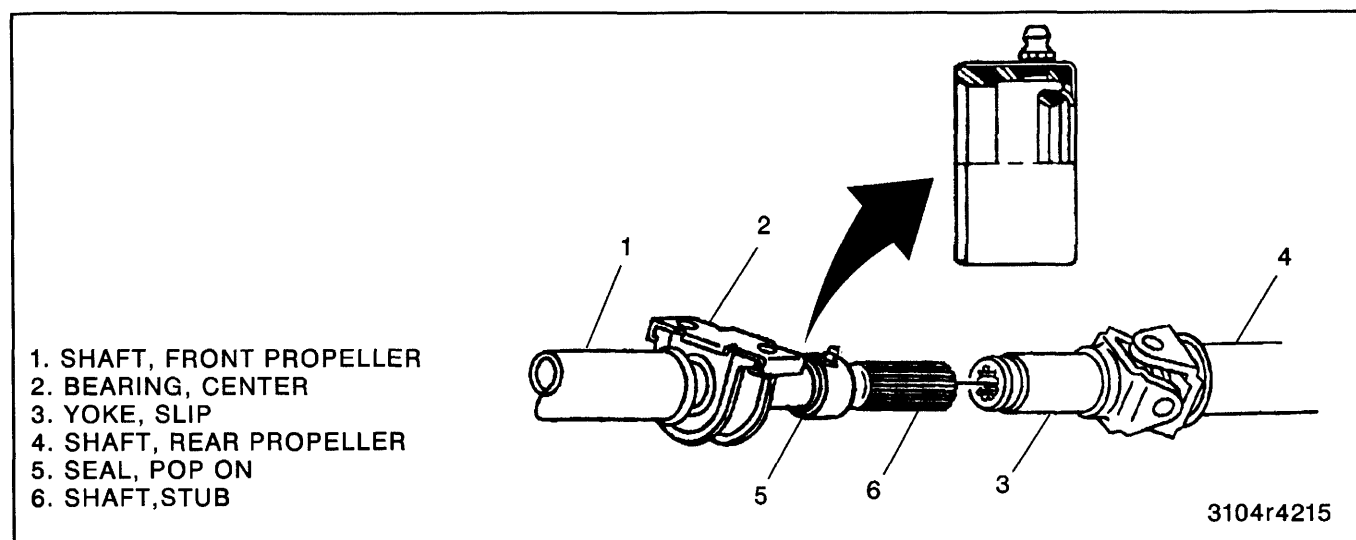


Figure 10—Two-Piece Propeller Shaft (Dana)

Install or Connect (Figure 4 and 11)

NOTICE: For steps 2, 5, 7, 10, and 12, refer to "Notice" on page 4A-1.

1. Front propeller shaft to yoke.
 - Make sure the reference marks are aligned.
 - Support front propeller shaft.
2. Bolts and retainers to yoke.

Tighten

- Bolts to 20 N.m (15 lbs. ft.) (without transmission mounted drum parking brake).
 - Bolts to 36 N.m (27 lbs. ft.) (with transmission mounted drum parking brake).
3. Front center bearing support to hanger.
 - Align the center bearing support 90 degrees to the propeller shaft center line. Refer to figure 4.
 4. Bolt and washers.
 5. Nuts.

Tighten

- Nuts to 35 N.m (26 lbs. ft.). Maintain alignment (figure 11).
6. Intermediate propeller shaft to front propeller shaft yoke.
 - Make sure reference marks are aligned.
 - Support intermediate propeller shaft.
 7. Bolts and retainers.

Tighten

- Bolts to 35 N.m (26 lbs. ft.).
 - Nuts to 35 N.m (26 lbs. ft.).
8. Rear center bearing support to hanger.
 - Align the center bearing support 90 degrees to both the front and intermediate propeller shaft centerlines. (figure 11).
 9. Bolts and washers.
 10. Nuts.

Tighten

- Bolts to 35 N.m (26 lbs. ft.). Maintain alignment (figure 11).
 - Support the rear propeller shaft.
11. Rear propeller shaft to rear axle pinion flange.
 - Make sure reference marks are aligned.
 12. Bolts and retainers.

Tighten

- Bolts to 36 N.m (26 lbs. ft.).

CENTER BEARING REPLACEMENT

Remove or Disconnect (Figure 11)

- Raise vehicle and support with safety stands.
1. Rear propeller shaft. Refer to "Propeller Shaft Replacement (Rear Drive)."
 2. Front or intermediate propeller shaft.
 3. Center bearing.
 - Stand propeller shaft on end in press with center bearing supported by press bars.
 - Press propeller shaft down and off center bearing.

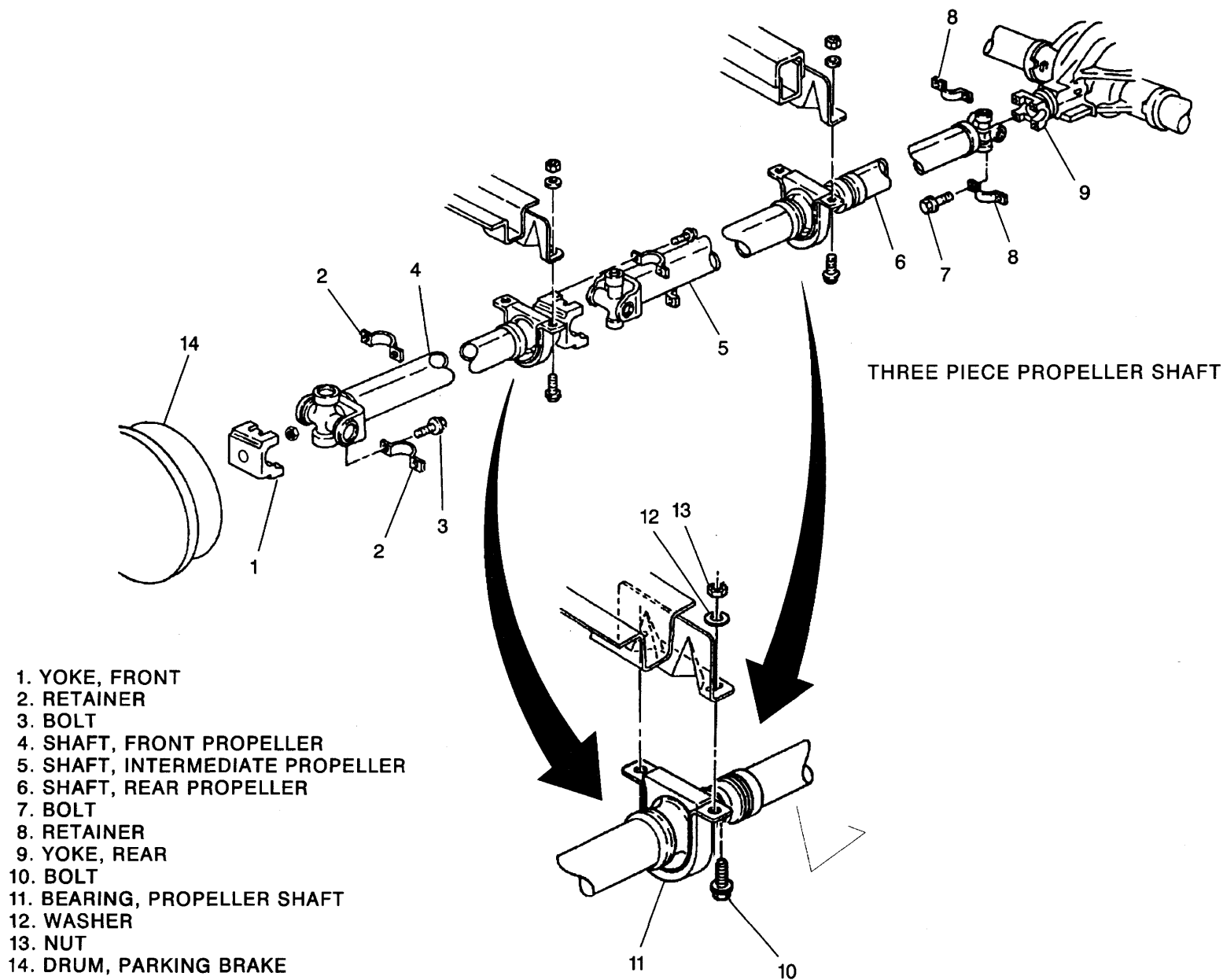
Install or Connect (Figure 4)

1. Center bearing onto propeller shaft.
 - Press center bearing onto shaft using a press.
2. Front or intermediate propeller shaft.

Important

- Center bearing must be aligned to prevent damage to propeller shaft assembly.
 - When bolting center bearing in place, be sure to keep it perpendicular (90° +/- 1°) to the propeller shaft, (figure 4).
3. Rear propeller shaft. Refer to "Propeller Shaft Replacement (Rear Drive)" in this section.

Figure 11—Three-Piece Propeller Shaft



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4A-12 PROPELLER SHAFT

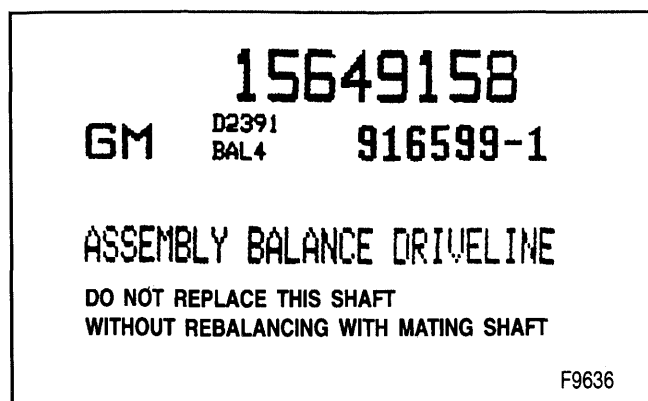


Figure 12—System Balanced Propeller Shaft Assembly Notice

NOTICE: Refer to "Notice" on page 4A-1.



Tighten

- All fasteners to 35 N.m (26 lbs. ft.).

4. Remove safety stands and lower vehicle.

SYSTEM BALANCED PROPELLER SHAFT ASSEMBLY REPLACEMENT



Important

- If one propeller shaft of a system balanced assembly is replaced, the mating shaft must be rebalanced with the replaced shaft. System balanced propeller shafts have a notice affixed to them similar to figure 12.



Remove or Disconnect (Figure 4)

- Raise the vehicle on a hoist.
- Reference mark all propeller shaft related components for reassembly including flanges and yokes.



Important

- Center slip yokes to spline shafts, end yokes, companion flanges, etc. must not be rotated from their original position during reassembly.

1. Bolts and retainers.
2. Propeller shaft.



Inspect

1. Boots for any damage (rips or holes).

- If boot is damaged it must be discarded. Clamps are not reusable.

2. Dust caps for any damage.

- If a push on dust cap must be removed it must be replaced.



Clean

- Propeller shaft, universal joints, and attachments with an approved solvent.

- If a boot must be disconnected, remove the clamp at the slip yoke end. Do not reuse the clamp.



Install or Connect

1. Propeller shaft.

NOTICE: Refer to "Notice" on page 4A-1.

2. Bolts and retainers.



Tighten

- Bolts to 20 N.m (15 lbs. ft.).

PROPELLER SHAFT REPLACEMENT (FRONT DRIVE)



Remove or Disconnect (Figure 13)

- Raise the vehicle on a hoist.
- Remove skid plate if used.
- Reference mark the relationship of the propeller shaft to the front axle and the transfer case flange.

1. Bolts and retainers.
2. Slip yoke from the front axle.



Important

- Do not pound on the joint to disconnect.
3. Bolts at the flange.
- Slide the propeller shaft forward, enough to disengage, then move the propeller shaft rearward.
 - Avoid dropping cap assemblies from the yoke ends.



Clean

- All parts with an approved solvent.



Inspect

- Splines for damage, wear, burrs, and twisting.
- Universal joint bearings for wear.
- Propeller shaft for any evidence of damage.



Install or Connect (Figure 13)

NOTICE: For steps 2 and 4, refer to "Notice" on page 4A-1.

- Extend the propeller shaft to its full length, then compress it about half its stroke.

1. Slip yoke to the front axle yoke.

- Adjust the propeller shaft length.
- Support the propeller shaft.

2. Retainers and the bolts to the front axle pinion flange.

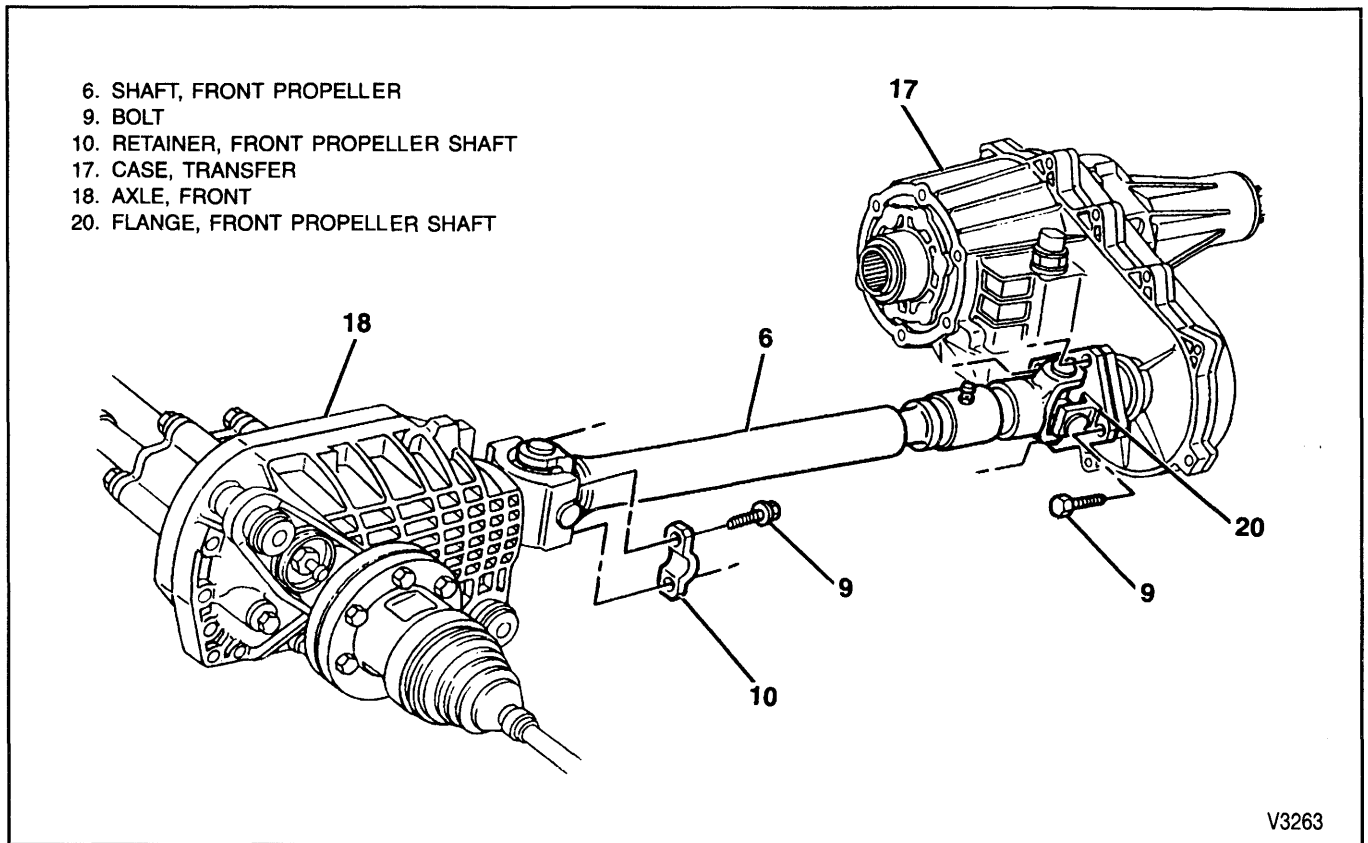


Figure 13—Front Drive Propeller Shaft



Tighten

- Retainer bolts to 20 N.m (15 lbs. ft.).

3. Propeller shaft to the transfer case yoke.
4. Retainer and the bolts to the transfer case yoke.



Tighten

- Retainer bolts to 100 N.m (74 lbs. ft.).

SLIP YOKE SPLINES

Apply chassis lubricant at the slip spline grease fitting until the grease begins to leave through the vent hole.

If the slip spline is dry or corroded, it may be necessary to disconnect the propeller shaft from the vehicle, remove the slip yoke, and wire brush the affected area. Wipe clean before installation. Replace if ground diameter has grooves worn in it from transmission extension housing bushing or seal.

UNIVERSAL JOINTS

NYLON INJECTED RING TYPE

NOTICE: Never clamp propeller shaft tubing in a vise. Clamping could dent or deform the tube causing an imbalance or unsafe condition. Always clamp on one of the yokes and support the shaft horizontally. Avoid damaging the slip yoke sealing surface. Nicks may damage the bushing or cut the lip seal.

Tools Required:

- J 9522-3 Universal Joint Bearing Separator
- J 9522-5 Universal Joint Bearing Spacer Remover

- Support the propeller shaft in a line horizontal with the table of a press.
- Mark the propeller shaft as to which end is the transmission end and which end goes to the rear axle.
- Place the universal joint so that the lower ear of the yoke is supported on a 1 1/8-inch socket (figure 14).
- In order to shear the plastic retaining ring on the bearing cup, place J 9522-3 on the open horizontal bearing cups and press the lower bearing cup out of the yoke ear. If the bearing cup is not completely removed, lift the cross and insert tool J 9522-5 between the seal and bearing cup being removed and continue to press it out of the yoke (figure 15).
- Rotate the propeller shaft and press the opposite bearing cup out of the yoke.



Disassemble

- Mark orientation of slip yoke to tube for proper reassembly.

1. The cross from the yoke.
2. Remaining universal joint parts from the yoke.
 - If the front universal joint is being replaced, remove the bearing cups in the slip yoke in the same manner.

4A-14 PROPELLER SHAFT

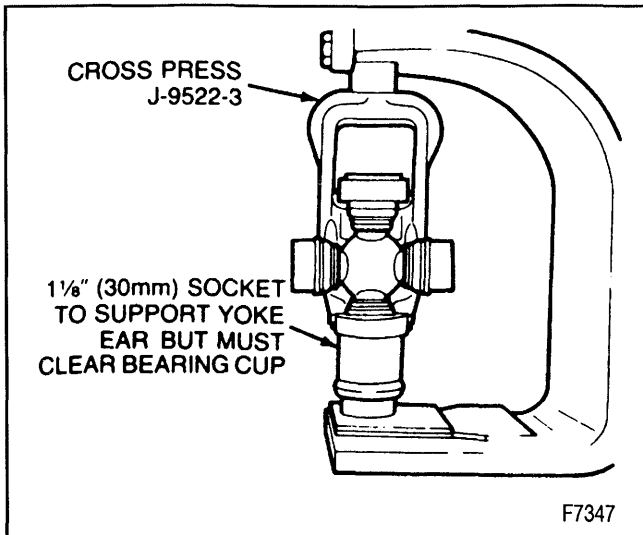


Figure 14—Pressing Out Universal Joint



Inspect

1. The retaining ring grooves for plastic.
2. The bearing cup bores in the yoke ears for burrs or imperfections.



Clean

- The remains of the sheared plastic bearing retainers from the grooves in the yoke.
- The sheared plastic may prevent the bearing cups from being pressed into place and thus prevent the bearing retainers from being properly seated.



Assemble

- Remove the bearing cups from the universal joint and use your finger to coat the needle bearings in the bearing cup with a thin layer of chassis grease.
1. One bearing cup part way into one side of the yoke (figure 16).
 - Turn the yoke ear toward the bottom.
 2. Cross into the yoke so the trunnion seats freely into the bearing cup.
 - With the trunnion seated in the bearing cup press the bearing cup into the yoke until it is flush with the yoke ear.
 3. The opposite bearing cup part way into the yoke ear.
 - Make sure that the trunnions are started straight and true into both bearing cups (figure 17).
 - Press the opposite bearing cup into the yoke ear while working the cross all the time to check for free unbinding movement of the trunnions in the bearing cups.
 - Press the bearing cup into the yoke until the bearing retainer groove clears the inside of the yoke.

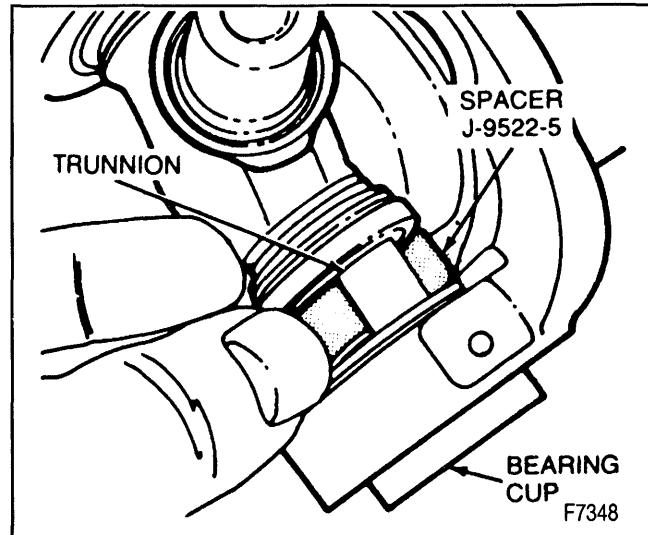


Figure 15—Using Available Spacer

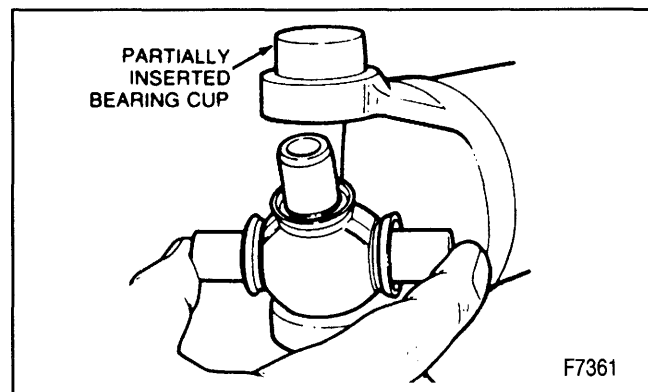


Figure 16—Partially Inserted Bearing Cup

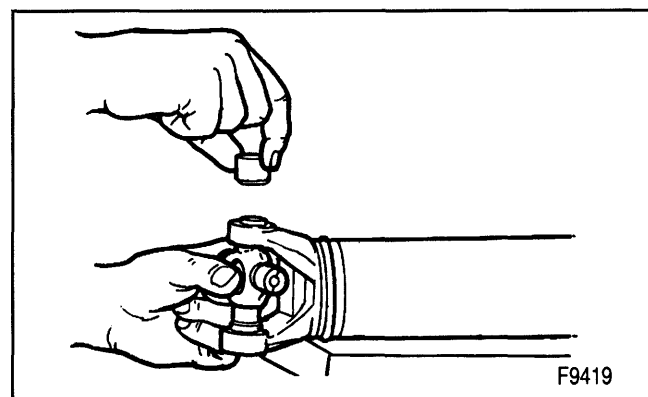


Figure 17—Aligning the Trunnion Between the Bearing Cups



Important

- If there seems to be a hangup or binding, stop pressing, and check the needle bearings for misalignment in the bearing cup.
4. Bearing retainer in the retainer groove (figure 18).
 - Continue to press until both retainers can be snapped into place.
 - If the retainer is difficult to seat, the yoke can be sprung slightly with a firm blow from a dead blow hammer (figure 19).

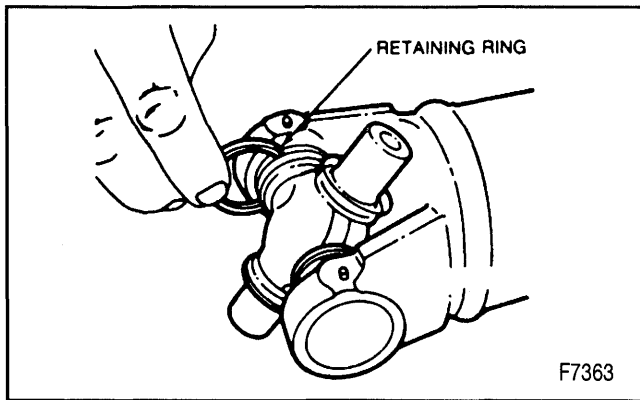


Figure 18—Installing Retaining Ring

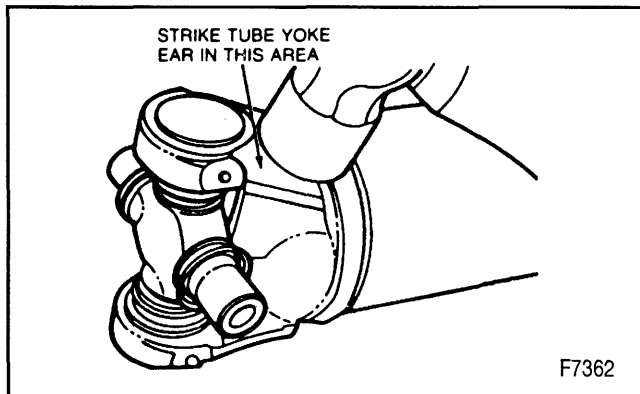


Figure 19—Seating the Universal Joint Snap Ring

- It may be necessary to lubricate the snap ring with a slight amount of chassis grease so it seats in the bearing cup groove.

EXTERNAL SNAP RING TYPE

NOTICE: *Never clamp propeller shaft tubing in a vise. Clamping could dent or deform the tube causing an imbalance or unsafe condition. Always clamp on one of the yokes and support the shaft horizontally. Avoid damaging the slip yoke sealing surface. Nicks may damage the bushing or cut the lip seal.*

Tools Required:

J 9522-3 Universal Joint Bearing Separator
J 9522-5 Universal Joint Bearing Remover
Spacer

- Support the propeller shaft in a line horizontal with the table of a press.
- Mark the propeller shaft to show which end connects to the transmission and which end goes to the rear axle.



Disassemble

1. Snap rings by pinching the ends together with a pair of pliers.
 - If the ring does not readily snap out of the groove in the yoke, tap the end of the bearing cup lightly to relieve the pressure from the ring.
 - Place the universal joint so the lower ear of the yoke is supported on a 1 1/8-inch socket (figure 14).

- Place J 9522-3 on the open horizontal bearing cups and press the lower bearing cup out of the yoke ear. If the bearing cup is not completely removed, lift the cross and insert tool J 9522-5 between the seal and bearing cup being removed and continue to press it out of the yoke (figure 15).
- Rotate the propeller shaft and press the opposite bearing cup out of the yoke.



Disassemble

- Mark orientation of slip yoke to tube for proper reassembly.
1. The cross from the yoke.
 2. Remaining universal joint parts from the yoke.
 - If the front universal joint is being replaced, remove the bearing cups in the slip yoke in the same manner.



Inspect

- The retaining ring grooves for dirt, corrosion, or pieces of the old ring.
- The bearing cup bores for burrs or imperfections.



Clean

- The retaining ring grooves.
- Corrosion, dirt, rust, or pieces of the old retaining ring may prevent the bearing cups from being pressed into place or prevent the bearing retainers from being properly seated.



Assemble

- Remove the bearing cups from the universal joint and use your finger to coat the needle bearings in the bearing cup with a thin layer of chassis grease.
1. One bearing cup part way into one side of the yoke (figure 16).
 - Turn the yoke ear toward the bottom.
 2. Cross into the yoke so that the trunnion seats freely into the bearing cup.
 - With the trunnion seated in the bearing cup press the bearing cup into the yoke until it is flush with the yoke ear (figure 17).
 3. The opposite bearing cup part way into the yoke ear.
 - Make sure that the trunnions are started straight and true into both bearing cups.
 - Press the opposite bearing cup into the yoke ear while working the cross all the time to check for free unbinding movement of the trunnions in the bearing cups.
 - Press the bearing cup into the yoke until the bearing cup retainer groove is visible over the top of the bearing cup.



Important

- If there seems to be a hangup or binding, stop pressing, and check the needle bearings for misalignment in the bearing cup.

4A-16 PROPELLER SHAFT

4. Bearing retainer in the retainer groove (figure 18).
- Continue to press until both retainers can be snapped into place.
 - If the retainer is difficult to seat, the yoke can be sprung slightly with a firm blow from a dead blow hammer (figure 19).

- It may be necessary to lubricate the snap ring with a slight amount of chassis grease so it seats in the bearing cup groove.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

APPLICATION	N·m	Lbs. Ft.
One-Piece Propshaft		
Rear Axle Retainer Bolt		
C/K 15-25	20	15
C/K 35	20	15
Two-Piece Propshaft—Front		
Yoke to M40 Transmission	120	90
Transmission Yoke Retainer Bolt	20	15
Transfer Case Yoke Retainer Bolt.....	20	15
Three-Piece Propshaft		
Front Axle Retainer Bolt		
Intermediate Retainer Bolt		
Rear Axle Retainer Bolt		
C/K 35	35	26
Center Bearing Support		
Crossmember Mounting Nut.....	35	26
Front Drive Propshaft		
Front Axle Retainer Bolt	20	15
Transfer Case Flange Bolt	100	74
		T2108

SPECIAL TOOLS

1.



J 9522-3

2.



J 9522-5

1. "U" Joint Bearing Separator
2. "U" Joint Bearing Spacer Remover
(Use with J 9522-3)

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SECTION 4B1

REAR AXLE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

These trucks use various rear axles. The axles can be identified by ring gear size in inches, by manufacturer (corporate or Dana) and by the type of axle shaft used (semi-floating or full-floating). Corporate axles include the 8 1/2, 9 1/2, and 10 1/2-inch ring gear axles. Dana supplies a 9 3/4, 10 1/2, and 11-inch ring-gear axles. The locking differential is supplied by Eaton.

REAR AXLE OPERATION

A basic differential has a set of four gears. Two are side gears and two are pinion gears. Some differentials have more than two pinion gears. Each side gear is splined to an axle shaft; so each axle shaft turns when its side gear rotates.

The pinion gears are mounted on a differential pinion shaft, and the gears are free to rotate on this shaft. The pinion shaft is fitted into a bore in the differential case and is at right angles to the axle shafts.

Power is transmitted through the differential as follows: the drive pinion rotates the ring gear. The ring gear, being bolted to the differential case, rotates the case. The differential pinion, as it rotates with the case, forces the pinion gears against the side gears. When both wheels have equal traction, the pinion gears do not rotate on the pinion shaft because the input force on the pinion gear is equally divided between the two side gears. Therefore, the pinion gears revolve with the pinion shaft, but do not rotate around the shaft itself. The side gears, being splined to the axle shafts and in mesh with the pinion gears, rotate the axle shafts.

If a vehicle were always driven in a straight line, the ring and pinion gears would be sufficient. The axle shaft could then be solidly attached to the ring gear and both driving wheels would turn at equal speed.

However, if it became necessary to turn a corner, the tires would scuff and slide because the outside wheel would travel further than the inside wheel. To prevent tire scuffing and sliding, the differential allows the axle shafts to rotate at different speeds.

When the vehicle turns a corner, the inner wheel turns slower than the outer wheel and slows its rear axle side gear (as the axle shaft is splined to the side

gear). The rear axle pinion gears will roll around the slowed rear axle side gear, driving the other rear axle side gear and wheel faster.

LOCKING REAR AXLE

The locking rear differential allows for normal differential function as indicated in the standard rear axle description. Additionally, the locking rear differential uses multi-disc clutch packs and a speed sensitive engagement mechanism that locks both wheels together if one wheel should spin excessively during slow vehicle operation.

Under light loads, the clutch plates alone tend to lock axle shafts to the differential case, and therefore, each other. This is due primarily to the gear separating load developed on the right clutch pack. This induced clutch torque capacity resists motion between the side gear and the rear axle differential case. The differential allows the wheels to turn at different speeds while the axle shafts continue to transmit the driving force. Also, heavier throttle application will cause an axle speed differential, but this starts the full-lock feature of the unit.

Full locking is accomplished through the use of a heavyweight governor mechanism, cam system, and multi-disc clutch packs. The flyweights on the governor mechanism move outward to engage a latching bracket whenever the wheel-to-wheel speed varies by approximately 100 rpm or more. This action retards a cam which, in turn, compresses the multi-disc clutch packs locking both side gears to the case. The 100 rpm wheel-to-wheel speed allows for cornering without differential lockup.

At vehicle speeds above approximately 32 km/h (20 mph), the latching bracket overcomes a spring preload and swings away from the flyweights. At this vehicle speed or greater, the differential is designed to not lock, since added traction is generally not needed.

All axle parts of vehicles equipped with the locking rear axle are interchangeable with those equipped with the conventional rear axle, except for the case assembly.

DIAGNOISIS OF REAR AXLE NOISE

DETERMINING REAR AXLE NOISE

Proper diagnosis is an important part of rear axle repair. In axle work one of the most difficult conditions to diagnose is noise. Locating a broken axle shaft or broken differential gear presents little or no problem, but locating and isolating axle noise can be an entirely different matter.

Any gear-driven unit, especially an automotive drive axle where engine torque multiplication occurs at a 90 degree turn in the drive line, produces a certain amount of noise. Therefore, an interpretation must be made for each vehicle to determine whether the noise is normal

or if a problem actually exists. A certain amount of noise must be expected and cannot be eliminated by conventional repairs or adjustment.

Normal axle noise can be described as a slight noise heard only at a certain speed or under unusual or remote conditions. For example, the noise tends to reach a peak at speeds from 60 to 100 km/h (40 to 60 mph) depending on road and load conditions, or on gear ratio and tire size. This slight noise is in no way indicative of trouble in the axle assembly.

Driveline noises may confuse even the best technician. Vehicle noises coming from tires, transmission, propeller shaft, universal joints, and front or rear wheel bearings are often mistaken for axle noise. Such prac-

tices as raising tire pressure to eliminate tire noise (although this will not silence tread noise of mud and snow tires), or listening for the noise at varying speeds and road surfaces, (drive, float, and coast conditions) will aid in locating the source of alleged axle noises. Every effort should be made to isolate the noise to a specific driveline component instead of making a random guess that could be a costly waste of time.

External Noise—Noise which seems to be coming from the rear axle may actually be produced somewhere else. Determine whether the noise might originate in the tires, road surface, front wheel bearings, engine, or transmission.

Road Noise—Driving on certain road surfaces, such as brick or rough-surfaced concrete, cause noise which may be mistaken for tire or rear axle noise. Driving on a different type of road, such as smooth asphalt or dirt, will quickly show whether the road surface is the cause of noise. Road noise usually is the same in drive or coast.

Tire Noise—Tire noise may easily be mistaken for rear axle noise, even though the noisy tires may be located on the front wheels. Tires worn unevenly, or having surfaces on non-skid divisions worn in saw-tooth fashion, are usually noisy and may produce vibrations which seem to originate elsewhere in the vehicle. This is particularly true with low tire pressure.

Tire Noise Test—Tire noise changes with different road surfaces, but rear axle noise does not. Temporarily inflating all tires to 345 kPa (50 psi) pressure, **for test purposes only**, will materially alter noise caused by tires but will not affect noise caused by the rear axle. Rear axle noise usually stops when coasting at speeds under 30 mph; however, tire noise continues but with lower tone as the vehicle speed is reduced. Rear axle noise usually changes when the tire "pulls" in a forward direction or when the vehicle "coasts" down the road and tire noise remains about the same.

Engine and Transmission Noises—Sometimes a noise which seems to originate in the rear axle is actually caused by the engine or transmission. To determine which unit is actually causing the noise, observe approximate vehicle speeds and conditions under which the noise is most pronounced; then stop the vehicle in a quiet place to avoid interfering noises. With the transmission in neutral, run the engine slowly up and down through the engine speeds corresponding to the vehicle speed at which the noise was most pronounced. If a similar noise is produced with the vehicle standing, it is caused by the engine or transmission and not the rear axle.

Front Wheel Bearing Noise—Loose or rough front wheel bearings will cause noise which may be confused with rear axle noise; however, front wheel bearing noise does not change when comparing "pull" and "coast" conditions. Light application of the brake, while holding the vehicle speed steady, will often cause the wheel bearing noise to diminish, since this takes some weight off of the bearing. Front wheel bearings may be easily checked for noise by jacking up the wheels and spinning them, and also by shaking the wheels to determine if the bearings are excessively loose.

Body Boom Noise or Vibration—Objectional "body boom" noise or vibration at 55-65 mph (90-100 km/h)

can be caused by an unbalanced propeller shaft. Excessive looseness at the spline can contribute to this unbalance.

Other items that may also contribute to the noise problem are as follows:

- Undercoating or mud on the shaft, causing unbalance.
- Shaft or companion flange balance weights missing.
- Shaft damage, such as bends, dents, or nicks.
- Rough tires. Switch tires from a known good vehicle to determine a tire fault.

If, after making a comprehensive check of the vehicle, all indications point to the rear axle, further diagnostic steps are necessary to determine the axle components at fault. True rear axle noise generally falls into two categories: gear noise and bearing noise.

Rear Axle Noises—If a careful test of the vehicle shows that the noise is not caused by external items, it is then reasonable to assume that noise is caused by the rear axle assembly. Test the rear axle on a smooth level road to avoid road noise. It is not advisable to test the rear axle for noise by running with the rear wheels jacked up.

Noise in the rear axle assembly may be caused by a faulty propeller shaft, faulty rear wheel bearings, faulty differential or pinion shaft bearings, misalignment between two U-joints, or worn differential side gears and pinions. Noise may also be caused by a mismatched, improperly adjusted, or scored ring and pinion gear set.

Rear Wheel Bearing Noise—A rough rear wheel bearing produces a vibration or growl which continues with the vehicle coasting and the transmission in neutral. A brinelled rear wheel bearing causes a knock or click approximately every two revolutions of the rear wheel, since the bearing rollers do not travel at the same speed as the rear axle and wheel. With the rear wheels jacked up, spin the rear wheels by hand while listening at the hubs for evidence of a rough or brinelled wheel bearing.

Differential Side Gear and Pinion Noise—Differential side gears and pinions seldom cause noise since their movement is relatively slight on straight ahead driving. Noise produced by these gears will be most pronounced on turns.

Pinion bearing failures can be determined by how the bearings rotate at higher speeds as opposed to differential side bearings and axle shaft bearings. Rough or brinelled pinion bearings produce a continuous low-pitched whirring or scraping noise starting at a low speed.

Side bearings produce a constant rough noise pitched lower than pinion bearing noise. Side bearing noise may also fluctuate in the previous rear wheel bearing test.

Gear Noise—There are two basic types of gear noise. The first type is produced by broken, bent, or forcibly damaged gear teeth and is usually quite audible over the entire speed range and presents no particular problem in diagnosis. For example, hypoid gear tooth scoring generally results from the following: insufficient lubricant, improper break-in, incorrect lubricant, insufficient gear backlash, improper ring and pinion gear

4B1-4 REAR AXLE

alignment, or loss of drive pinion nut torque. The scoring will progressively lead to complete erosion of the gear tooth, or gear tooth pitting and then eventual fracture if the initial scoring condition is not corrected (figure 1).

Other causes of hypoid tooth fracture are extended overloading of the gear set which will produce fatigue fracture, or shock loading which will result in sudden malfunction.

Differential pinion and side gears rarely give trouble. Common causes of differential malfunction are shock loading, extended overloading, and seizure of the differential pinions to the cross shaft resulting from excessive wheel spin and consequent lubrication breakdown. The second type of gear noise pertains to the mesh pattern of the gear teeth. This form of abnormal gear noise can be recognized because it produces a cycling pitch (whine) and will be very pronounced in the speed range at which it occurs, appearing under either "drive," "float," or "coast" conditions. "Drive" is acceleration or heavy pull. "Coast" is allowing the vehicle roll down the road without accelerating and "float" is lightly stepping on the accelerator pedal to keep the vehicle from driving the engine; the vehicle slows down gradually but the engine still pulls slightly. Gear noise tends to peak

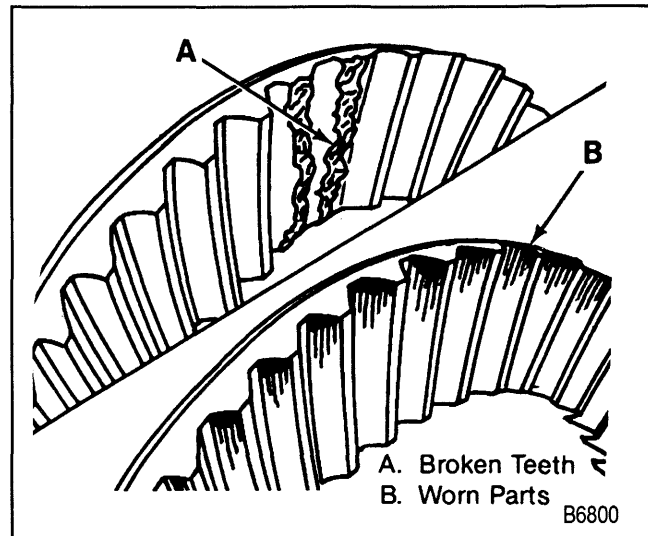


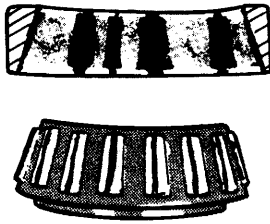
Figure 1—Causes of Gear Noise

in a narrow speed range or ranges and will tend to remain constant in pitch. Bearing noise will vary in pitch with vehicle speeds.

Refer to figures 2 and 3 for bearing diagnosis.

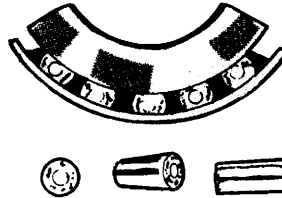
TAPERED ROLLER BEARING DIAGNOSIS

- Consider the following factors when diagnosing bearing condition:
1. General condition of all parts during disassembly and inspection.
 2. Classify the failure with the aid of the illustrations.
 3. Determine the cause.
 4. Make all repairs following recommended procedures.



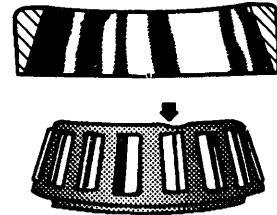
ABRASIVE ROLLER WEAR

Pattern on races and rollers caused by fine abrasives. Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



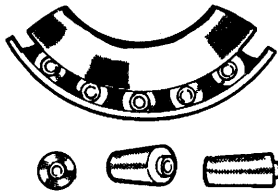
GALLING

Metal smears on roller ends due to overheating, lubricant failure or overload. Replace bearing, check seals and check for proper lubrication.



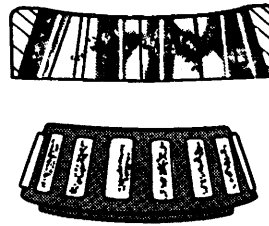
BENT CAGE

Cage damaged due to improper handling or tool usage. Replace bearing.



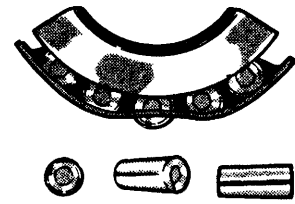
ABRASIVE STEP WEAR

Pattern on roller ends caused by fine abrasives. Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



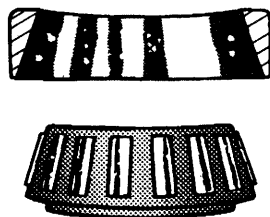
ETCHING

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing. Replace bearings, check seals, and check for proper lubrication.



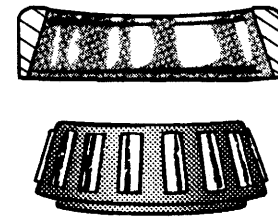
BENT CAGE

Cage damaged due to improper handling or tool usage. Replace bearing.



INDENTATIONS

Surface depressions on race and rollers caused by hard particles of foreign material. Clean all parts and housings. Check seals and replace bearings if rough or noisy.



MISALIGNMENT

Outer race misalignment due to foreign object. Clean related parts and replace bearing. Make sure races are properly sealed.

F9315

Figure 2—Diagnosis of Tapered Roller Bearings

Diagnosis of Tapered Roller Bearings (con't)



FATIGUE SPALLING

Flaking of surface metal resulting from fatigue.
Replace bearing, clean all related parts.



STAIN DISCOLORATION

Discoloration can range from light brown to black caused by incorrect lubricant or moisture.
Re-use bearings if stains can be removed by light polishing or if no evidence of overheating is observed.
Check seals and related parts for damage.



FRETTAGE

Corrosion set up by small relative movement of parts with no lubrication.
Replace bearing. Clean related parts.
Check seals and check for proper lubrication.



CAGE WEAR

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.
Clean related parts and housings.
Check seals and replace bearings.



HEAT DISCOLORATION

Heat discoloration can range from faint yellow or dark blue resulting from overload or incorrect lubricant. Excessive heat can cause softening of races or rollers. To check for loss of temper on races or rollers a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas, a file drawn over a hard part will glide readily with no metal cutting.
Replace bearings if overheating damage is indicated.
Check seals and other parts.



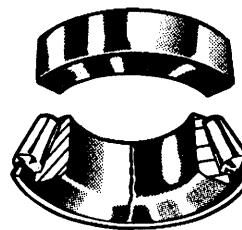
BRINELLING

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.
Replace bearing if rough or noisy.



SMEARS

Smearing of metal due to slippage. Slippage can be caused by poor fits, lubrication, overheating, overloads or handling damage.
Replace bearings, clean related parts and check for proper fit and lubrication.



CRACKED INNER RACE

Race cracked due to improper fit, cocking, or poor bearing seats.
Replace bearing and correct bearing seats.

Figure 3—Diagnosis of Tapered Roller Bearings

ON-VEHICLE SERVICE

SEMI-FLOATING AXLE (8 1/2 AND 9 1/2-INCH RING GEAR)

VENT HOSE REPLACEMENT

The axle vent hose is located on the axle carrier on 8 1/2, 9 1/2, and 10 1/2-inch ring gear axles.

Remove or Disconnect (Figure 4)

1. Vent clamp bolt from the brake bracket.
2. Clamp from the brake bracket.
3. Vent assembly from the hose.
4. Clamp from the hose.
5. Hose clamp bolt from the hose clamp and the brake junction block, (8 1/2 and 9 1/2 inch ring gear axles only).
6. Hose clamp and hose from the axle nipple.
7. Hose clamp from the hose.

Install or Connect (Figure 4)

NOTICE: Refer to "Notice" on page 4B1-1.

1. Hose clamp to the hose.
2. Hose clamp and hose to the axle nipple.
3. Hose clamp bolt to the hose clamp and the brake junction block (8 1/2 and 9 1/2-inch ring gear axles only).

4. Clamp to the hose.
5. Vent assembly to the hose.
6. Clamp to the brake bracket.
7. Vent clamp bolt to the brake bracket.

REAR AXLE ASSEMBLY REPLACEMENT

- Raise the vehicle on a hoist and support the axle assembly with a suitable lifting device.
- For 10 1/2-inch ring gear axles, raise the vehicle and place jack stands under the frame side rails for support.
- Drain the lubricant from the axle housing.

Remove or Disconnect (Figure 4)

1. Propeller shaft. Refer to SECTION 4A.
 - Tie the propeller shaft to a side rail or crossmember.
 - Tape the bearing cups to prevent loss of the needle bearings.
2. Wheel and brake drum or hub and drum assembly. Refer to SECTION 5A2.
3. Parking brake cable from the lever and at the brake backing plate.

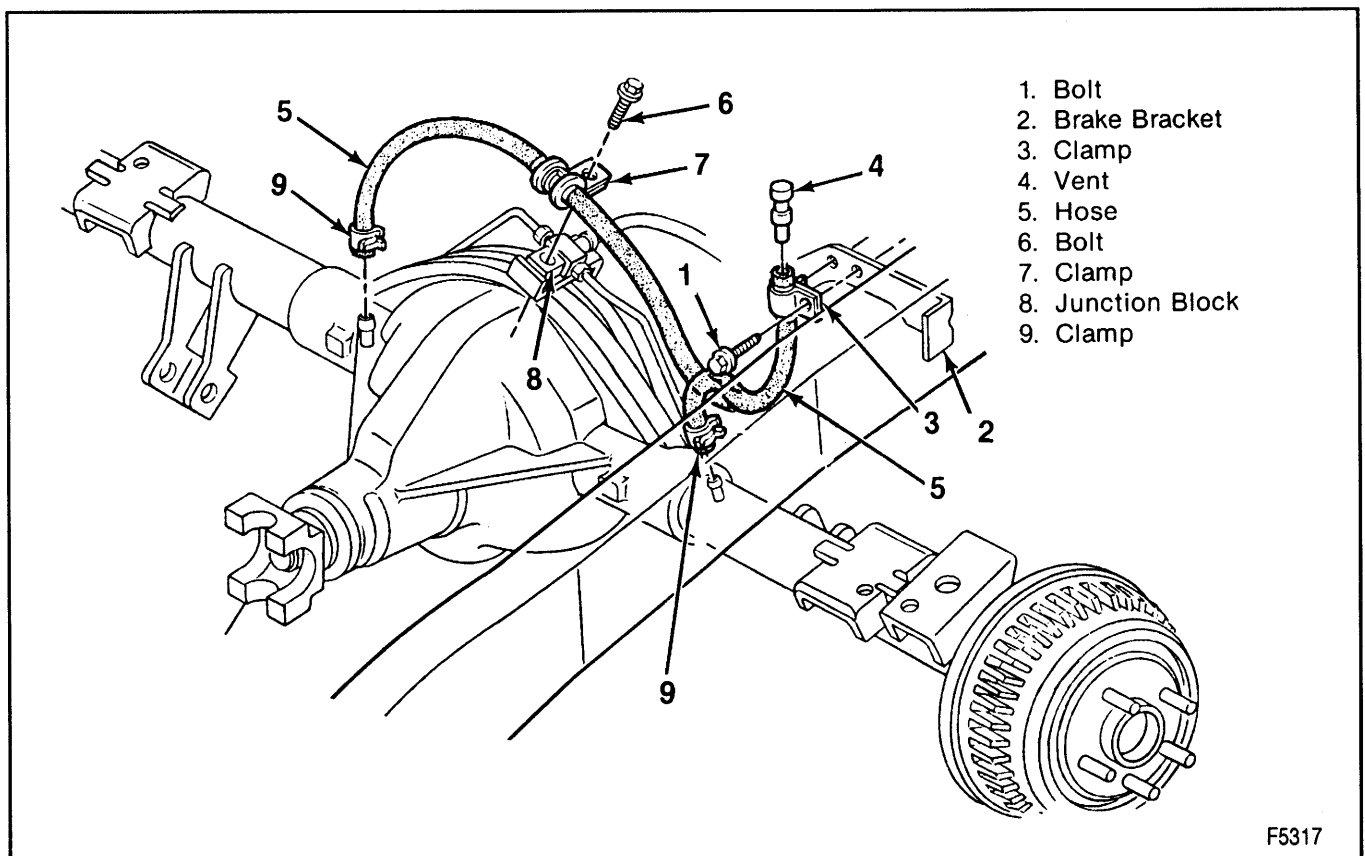


Figure 4—Axle Vent Hose

4B1-8 REAR AXLE

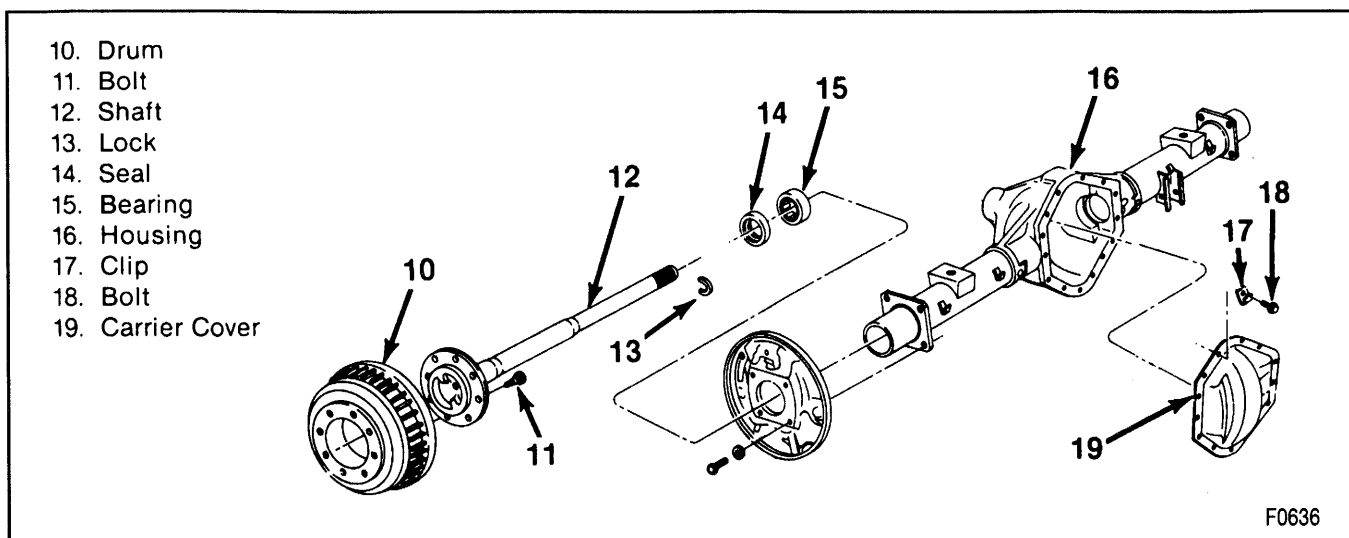


Figure 5—Axle Shaft and Housing Components

4. Hydraulic brake pipes from the connectors.
5. Shock absorbers from the axle brackets.
6. Vent hose from the axle vent fitting.
7. Height sensing and brake proportional valve brackets if used.
 - Support the assembly with a hydraulic floor jack.
8. Nuts and washers from the U-bolts.
9. U-bolts, spring plates, and spacers from the axle assembly.
 - Lower the jack and the axle assembly.

- B. Bleed the brake system, check operation, and adjust if necessary. Refer to SECTION 5.
- C. Check axle and brake operation.
- D. Check for fluid leaks and road test the vehicle.

AXLE SHAFT, OIL SEAL, AND BEARING REPLACEMENT

Tools Required:

- J 2619-01 Slide Hammer with Adapter
- J 23689 Axle Shaft Bearing Remover (large shaft)
- J 29712 Axle Shaft Bearing Remover (9 1/2-inch ring gear)

Install or Connect (Figure 4)

1. Axle assembly under the vehicle.
 - Align the axle assembly with the springs.
2. Spacers, spring plates, and U-bolts to the axle assembly.
 - Raise the axle assembly.
3. Washers and nuts to the U-bolts.
 - Thread the nuts on firmly.
 - Adjust alignment of semi-float axles.
4. Height sensing and brake proportional valve linkage (if used).
5. Vent hose to the axle vent fitting (if used).
6. Shock absorbers to the axle brackets.
7. Hydraulic brake pipes to the connectors.
8. Parking brake cable to the lever and the backing plate.
9. Wheel and brake drum or hub and drum assembly.
10. Propeller shaft.

NOTICE: Refer to "Notice" on page 4B1-1.

Tighten

- All fasteners to "Specifications" at the end of this section.

Important

- A. Check axle lubricant level at the filler plug hole. Lubricate as needed. Refer to SECTION 0B.

Remove or Disconnect (Figures 5 through 11)

- Raise the vehicle on a hoist.
1. Wheel and tire assembly.
 2. Brake drum.
 - Clean the dirt from around the carrier cover.
 3. Carrier cover.
 - Catch the oil in a drain pan.

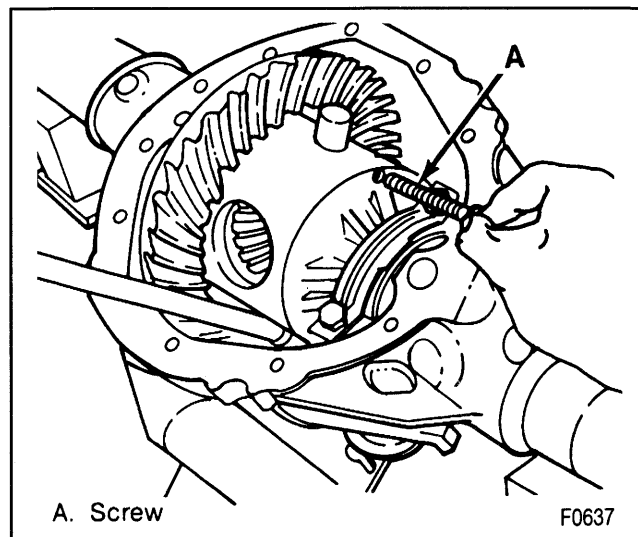


Figure 6—Removing the Pinion Shaft Lock Bolt

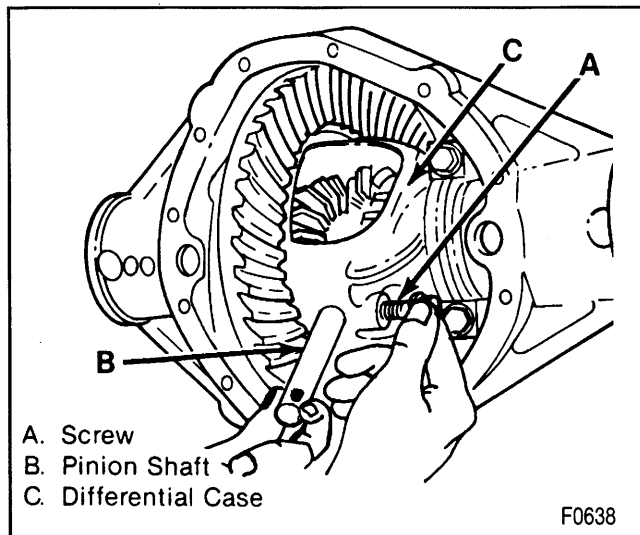


Figure 7—Removing/installing the Pinion Shaft

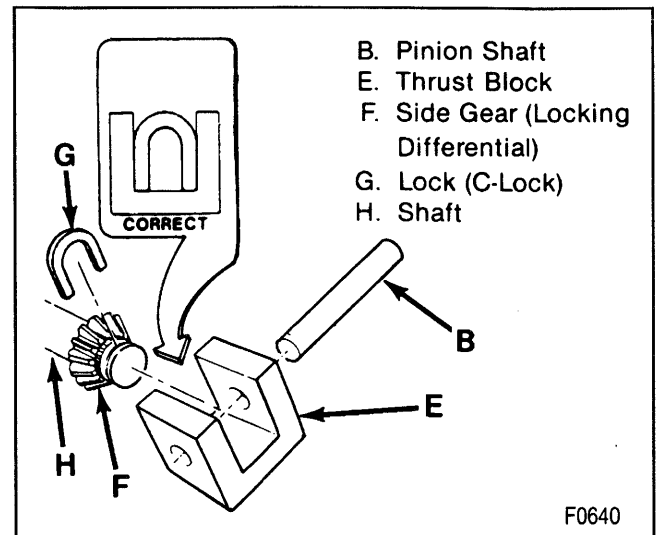


Figure 9—Aligning the Lock

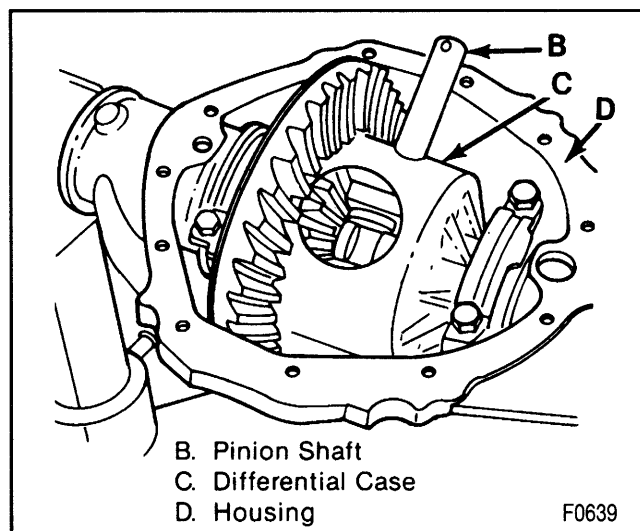


Figure 8—Positioning the Case for Best Clearance

- Remove gasket material if used.

4. Screw (A).

5. Pinion shaft (B).

- Remove the shaft from the case on vehicles without a locking differential.
- With a locking differential, remove the shaft (B) part way, and rotate the case until the pinion shaft touches the housing.
- Use a screwdriver or similar tool to enter the case and rotate the lock until it aligns with the thrust block.

6. Lock (figure 9).

- Push the flange of the axle shaft towards the differential. Do not force or hammer the shaft to move the axle shaft (figure 10).
- Remove the lock from the button end of the axle shaft.

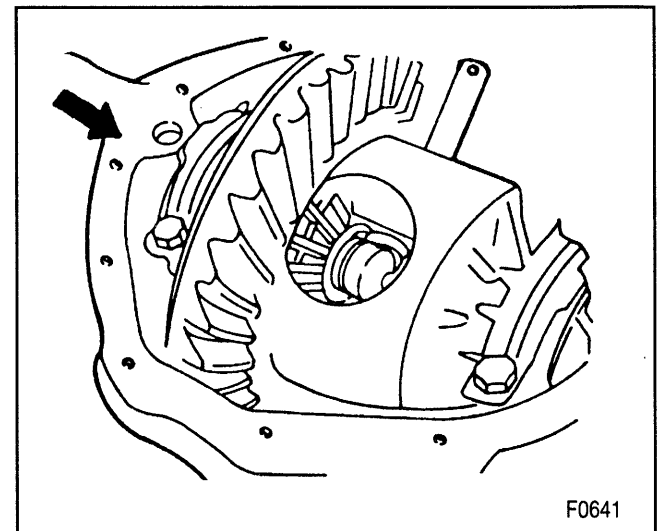


Figure 10—Pushing the Axle Shaft Inward

7. Axle shaft.

- Slide the axle shaft out, being careful not to damage the seal.

8. Seal using J 23689.

9. Bearing.

A. Use J 23689 for 8 1/2-inch ring gear axle or J 29712 for 9 1/2-inch ring gear to pull the bearing from the axle.

B. Insert the tool into the axle bore so that it grasps behind the bearing (figure 11). Tighten the nut and washer against the face of the bearing. Pull the bearing out using J 2619-01.



Inspect

- All parts. Replace as necessary.



Install or Connect (Figures 5, 9, 12, and 13)

NOTICE: For steps 6 and 9, refer to "Notice" on page 4B1-1.

4B1-10 REAR AXLE

Tools Required:

- J 8092 Driver Handle
- J 21128 Axle Shaft and Pinion Oil Seal Installer
- J 23690 Axle Shaft Bearing Installer
- J 29709 Axle Shaft Bearing Installer
(9 1/2-inch ring gear)
- J 29713 Axle Shaft Seal Installer
(9 1/2-inch ring gear)

- Lubricate the axle cavity between the seal lips and the bearing with wheel bearing lubricant. Refer to SECTION 0B.

1. Bearing.

- Use J 23690 for the 8 1/2-inch gear axle and J 29709 for the 9 1/2-inch ring gear axle.
- Bearing into the axle housing until the tool bottoms against the tube. Refer to figure 12.

2. Seal.

- Use J 21128 for 8 1/2-inch ring gear axle and J 29713 for the 9 1/2-inch ring gear axle.
- Drive the tool into the bore until the seal bottoms flush with the end of the tube (figure 13).

3. Axle shaft.

- Be careful not to damage the seal when inserting the axle shaft.
- Slide the axle shaft into place allowing the splines to engage the differential side gear (F) (figure 9).

4. Lock.

- Without locking differential:
 - Place the lock on the button end of the axle shaft, then pull the shaft flange outward to seat the lock in the differential side gear.
- With locking differential:
 - A. Keep the pinion shaft partially withdrawn (figure 7).
 - B. Place the lock in the position shown in figure 9. Pull the shaft flange outward to seat the lock in the differential side gear.

5. Pinion shaft (figure 6).

- Align the hole in the pinion shaft with the screw hole in the differential case.

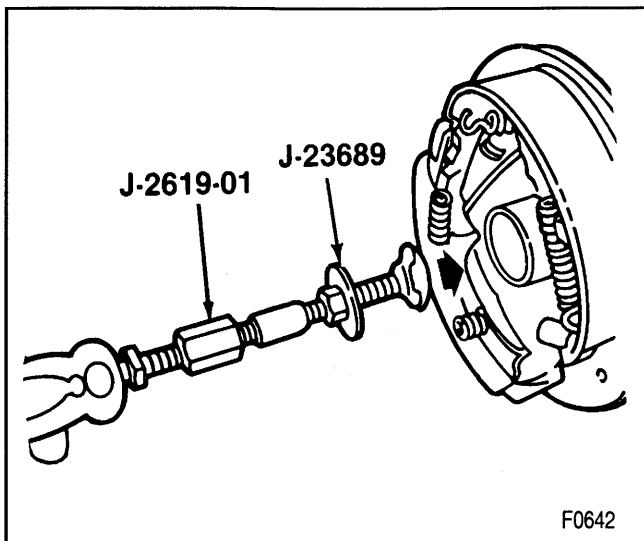


Figure 11—Removing the Bearing and Seal

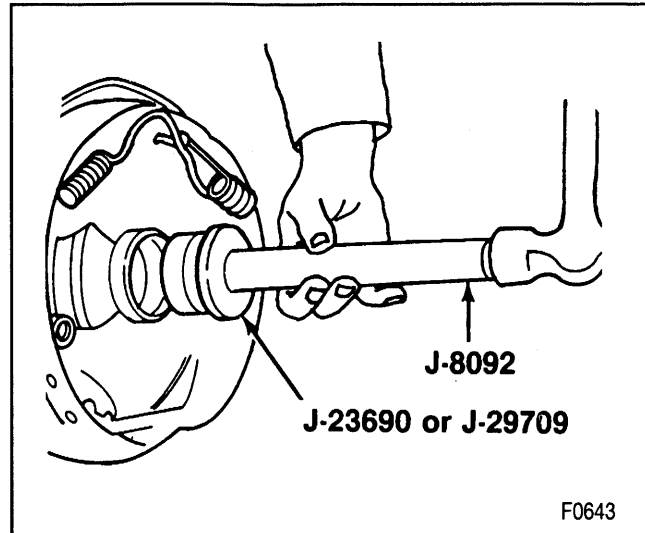


Figure 12—Installing the Wheel Bearing

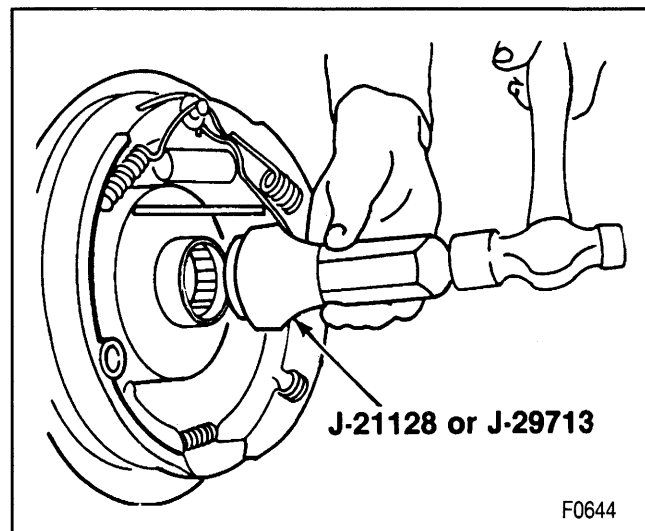


Figure 13—Installing the Seal

! Important

- Anytime a differential pinion shaft locking screw is removed, it is important to coat the screw threads with Loctite 242 before reinstalling. These screws are coated with an adhesive which helps to prevent the screw from loosening in the case. When this screw is removed, the adhesive is also removed.

6. Screw (A).

Tighten

- Screw to 36 N.m (27 lbs. ft.).

7. Carrier cover gasket or RTV (if used).

8. Carrier cover.

9. Bolts and clip.

Tighten

- Bolts in a crosswise pattern to 41 N.m (30 lbs. ft.).

10. Brake drum.
11. Wheel and tire assembly.
 - Lower the vehicle.
12. Axle lubricant. Fill to the filler plug hole level. Refer to SECTION 0B.

BRAKE BACKING PLATE REPLACEMENT

- Raise the vehicle on a hoist.

↔ Remove or Disconnect (Figure 5)

1. Wheel, tire, and brake drum.
2. Axle shaft. Refer to "Axle Shaft Replacement."
3. Brake pipe from the wheel cylinder.
4. Brake components from the backing plate. Refer to SECTION 5.
5. Bolts and washers from the axle.
6. Backing plate.

↔ Install or Connect (Figure 5)

1. Backing plate to the axle.
2. Bolts and washers to the plate.
3. Brake components to the backing plate. Refer to SECTION 5.
4. Brake pipe to the wheel cylinder.
 - Refer to SECTION 5 for bleeding and adjustment procedure.
5. Axle shaft. Refer to "Axle Shaft Replacement."
6. Wheel, tire, and brake drum.

WHEEL STUD REPLACEMENT

- Raise the vehicle on a hoist and allow the axle to hang free.

↔ Remove or Disconnect

Tool Required:
J 6627-A Wheel Stud Remover

1. Wheel, tire, and brake drum.
2. Stud from the axle flange using J 6627-A (figure 14).

↔ Install or Connect

1. Stud in the axle flange hole.
 - A. Start the new stud into the axle flange hole by pressing firmly with your hand.
 - B. Thread on a lug nut with the flat side to the vehicle.
 - C. Tighten the lug nut and draw the stud into the rear of the flange.
 - D. Thread the lug nut off.
2. Wheel, tire and brake drum.
 - Lower the vehicle.

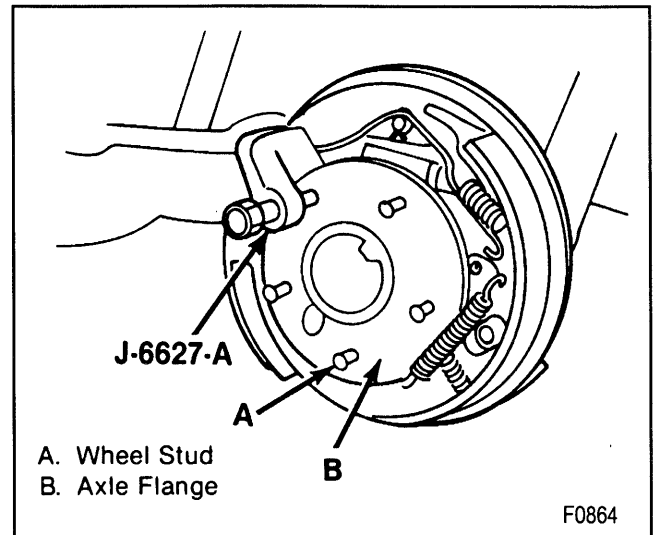


Figure 14—Pressing Out a Wheel Stud

PINION FLANGE AND DUST DEFLECTOR/OIL SEAL REPLACEMENT

↔ Remove or Disconnect (Figures 15 through 18)

Tool Required:

J 8614-01 Companion Flange Holder and Remover

- Raise the vehicle on a hoist.
1. Propeller shaft from the axle.
 - Tie the propeller shaft to a frame rail or cross-member.

📏 Measure

- The torque required to rotate the pinion (figure 15). Record the torque value for later reference.

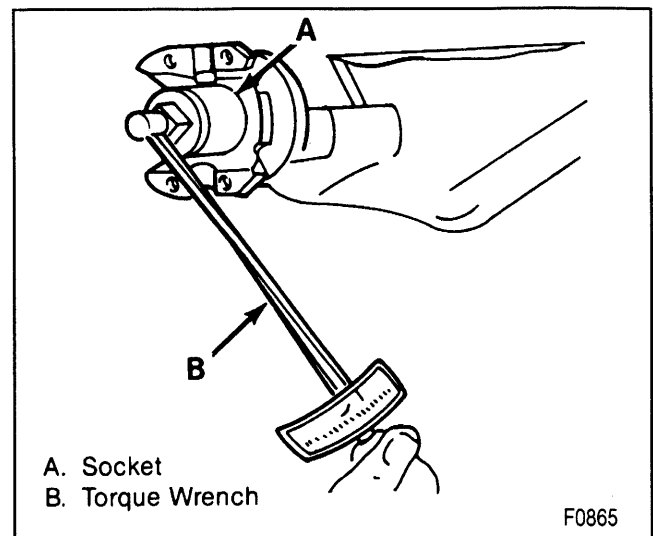


Figure 15—Measuring Pinion Rotating Torque

4B1-12 REAR AXLE

! Important

- Scribe a line on the pinion stem, pinion nut and the companion flange and record the number of exposed threads on the pinion stem. Use the scribed reference and the exposed threads as a reinstallation guide (figure 16).
2. Nut using J 8614-01.
 - Position J 8614-01 on the flange so that the four notches on the tool face the flange (figure 17).
 3. Flange using J 8614-01
 - Use the special nut and forcing screw to remove the flange (figure 18).
 4. Oil seal using a seal removal tool.

L Inspect

- The pinion flange for a smooth oil seal surface, for worn drive splines, damaged ears, and for smoothness of the bearing contact surface. Replace if necessary.

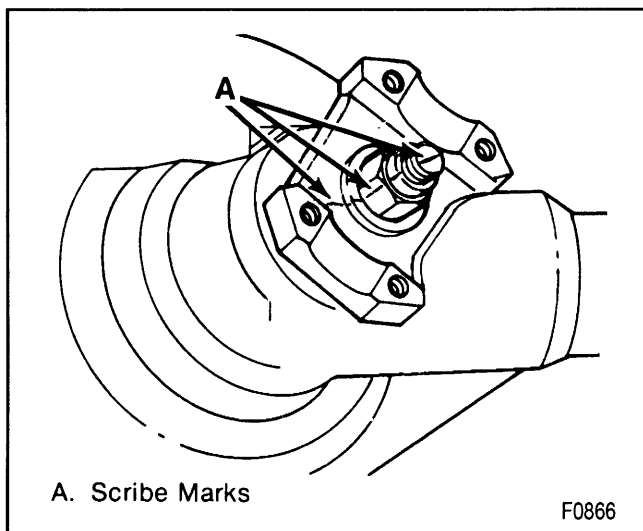


Figure 16—Scribed Marks

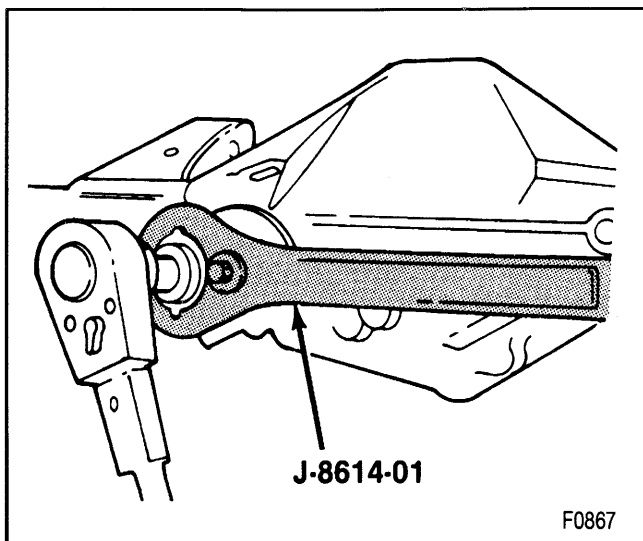


Figure 17—Removing the Drive Pinion Nut

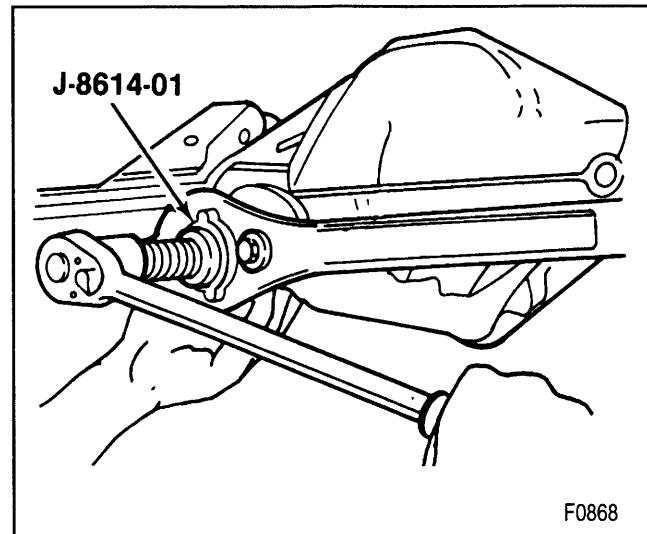


Figure 18—Removing the Drive Pinion Flange

5. Dust deflector.
 - Tap the deflector from the flange if replacement is necessary.
 - Clean up the stake points on the flange.
 - Clean all foreign material from the contact area.

↔ Install or Connect (Figures 19 and 20)

Tools Required:

- J 8614-01 Companion Flange Holder and Remover
- J 22388 Pinion Oil Seal Installer (9 1/2-inch ring gear)
- J 22804-1 Pinion Oil Seal Spacer
- J 22836 Pinion Seal Installer (8 1/2-inch ring gear)

1. Dust deflector on the flange.
 - Stake new deflector at three new equally spaced positions. Staking must be such that the seal operating surface is not damaged.
2. Oil seal.
 - A. Pack the cavity between the lips of the oil seal with extreme pressure lithium-base lubricant.
 - B. Position the oil seal in the bore. Then place J 22804-1 over the oil seal and flat against the seal flange (figure 19).

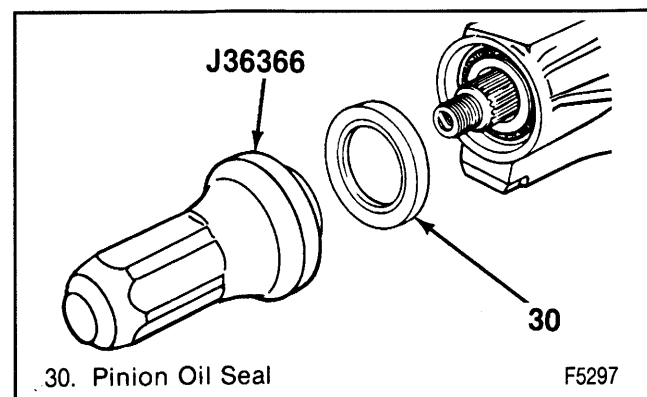


Figure 19—Installing the Pinion Seal

- C. Use J 22836 for the 8 1/2-inch ring gear or J 22388 for the 9 1/2-inch ring gear to press the oil seal into the bore.
- D. Turn J 22804-1 from installed position 180 degrees to ensure proper installation against the pinion flange.

NOTICE: Refer to "Notice" on page 4B1-1.

- 3. Flange onto the pinion using J 8614-01 (figure 20).
 - Place washer and nut on the pinion threads and tighten the nut to the original scribed position using the scribe marks and exposed threads as a reference (figure 16).

NOTICE: Do not hammer the pinion flange onto the pinion shaft or the pinion flange may be damaged.



Measure

- The rotating torque of the pinion and compare with the torque recorded earlier (figure 15).



Tighten

- The pinion nut in additional small increments until the torque necessary to rotate the pinion exceeds the original recorded value by 0.35 N·m (3 lbs. in.).

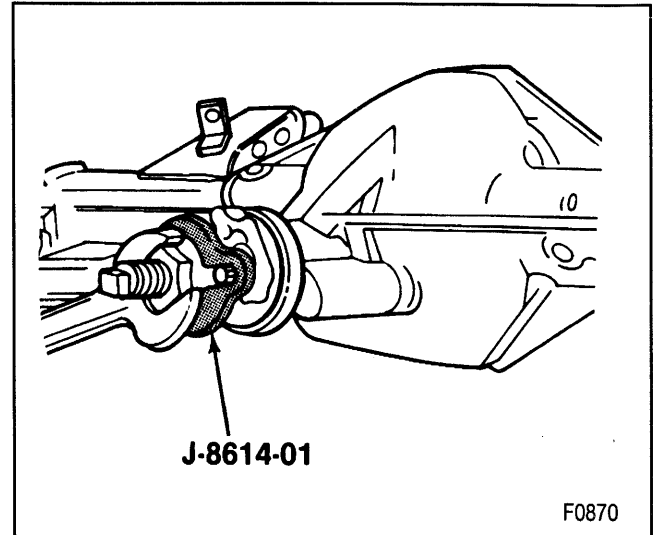


Figure 20—Installing the Pinion Flange

- 4. Propeller shaft.
 - Lower the vehicle and road test.

FULL-FLOATING AXLE (10 1/2-INCH RING GEAR)

AXLE SHAFT REPLACEMENT



Remove or Disconnect (Figure 21)

- 1. Bolts.
 - Rap the axle shaft flange lightly with a soft-faced hammer to loosen the shaft.
 - Grip the rib on the axle shaft flange with a locking plier and twist, to start shaft removal.
- 2. Axle shaft from the tube.



Clean

- Axle shaft flange. Remove old RTV or gasket.
- Outside face of the hub assembly.



Inspect

- All parts and replace as necessary.



Install or Connect

- 1. Axle shaft with a gasket or RTV applied.
 - Be sure the shaft splines mesh into the differential side gear.
 - Align the axle shaft holes with the hub holes.

NOTICE: Refer to "NOTICE" on page 4B1-1.

- 2. Bolts.



Tighten

- Bolts to 156 N·m (115 lbs. ft.).

HUB AND DRUM ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 21)

Tool Required:

J 2222-C Wheel Bearing Nut Wrench

- Raise the vehicle until the wheel is free to rotate.
- 1. Wheel and tire.
- 2. Axle shaft as outlined earlier in this section.
- 3. Retaining ring.
- 4. Key.
- 5. Adjusting nut.
- 6. Washer.
- 7. Hub and drum.



Inspect

- All parts and replace as necessary.



Install or Connect (Figures 21 and 22)

Tool Required:

J 2222-C Wheel Bearing Nut Wrench

- 1. Hub and drum to the tube.
 - Be sure the bearings and the oil seal are positioned properly.
 - Apply a light coat of high melting point EP bearing lubricant to the contact surfaces and the outside of the axle tube.

4B1-14 REAR AXLE

2. Washer.

- Place the tang into the keyway.

3. Adjusting nut.



Adjust

- Bearing preload. Refer to "Bearing Adjustment."

4. Key.

5. Retaining ring.

6. Axle shaft as described earlier in this section.

7. Wheel and tire.

- Lower the vehicle.

WHEEL BEARING/CUP REPLACEMENT

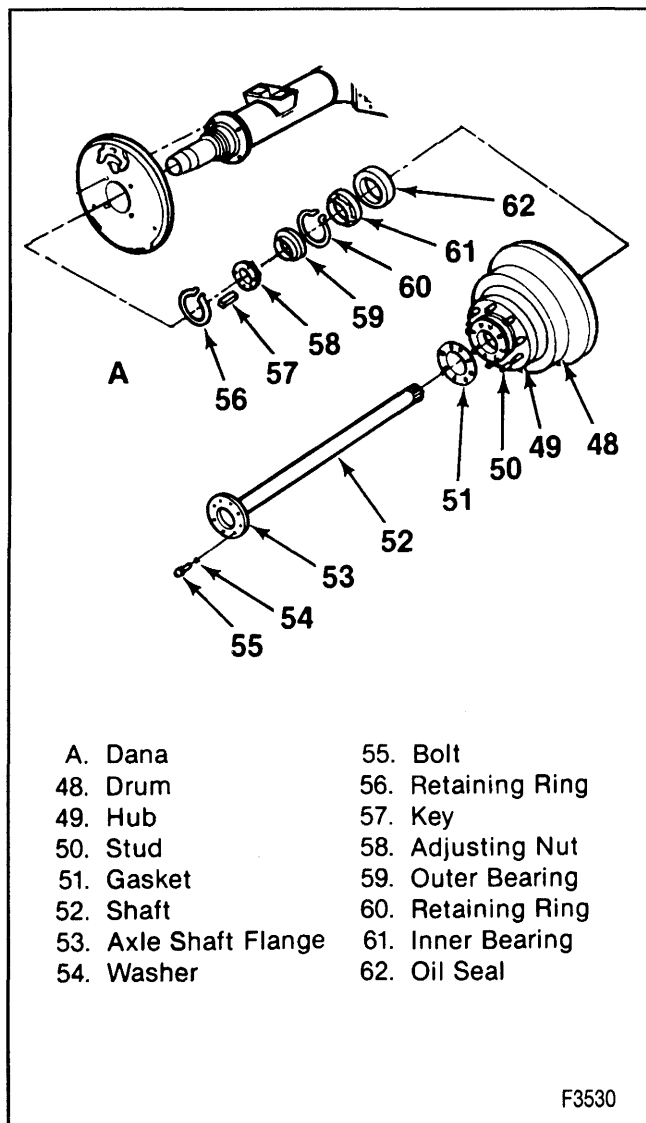


Remove or Disconnect (Figure 21 and 23)

Tools Required:

J 8092 Driver Handle

J 24426 Outer Wheel Bearing Cup Installer



- | | |
|-----------------------|--------------------|
| A. Dana | 55. Bolt |
| 48. Drum | 56. Retaining Ring |
| 49. Hub | 57. Key |
| 50. Stud | 58. Adjusting Nut |
| 51. Gasket | 59. Outer Bearing |
| 52. Shaft | 60. Retaining Ring |
| 53. Axle Shaft Flange | 61. Inner Bearing |
| 54. Washer | 62. Oil Seal |

F3530

Figure 21—Full Floating Axle, Hub, and Drum Assembly Components

- Raise the vehicle until the wheels are free to rotate.

1. Axle shaft as outlined earlier in this section.

2. Hub and drum as outlined earlier in this section.

3. Oil seal.

4. Inner bearing. Use a drift to remove the bearing and cup.

5. Retaining ring.

- Use snap ring pliers to remove the ring.

6. Outer bearing using J 8092 with J 24426 (figure 23).

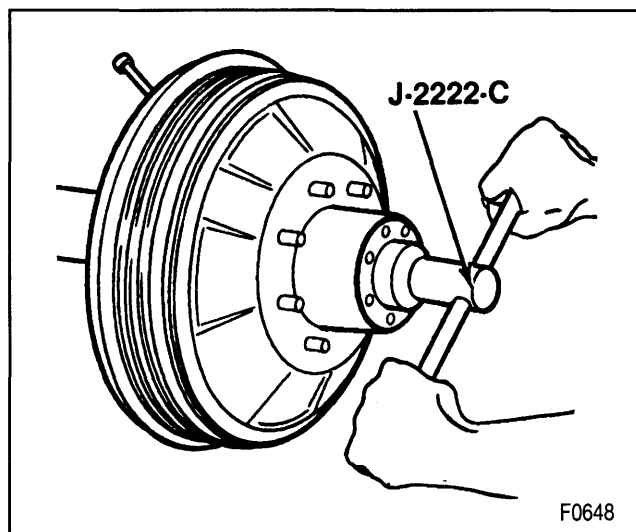
- Drive the bearing and cup from the hub.



Clean

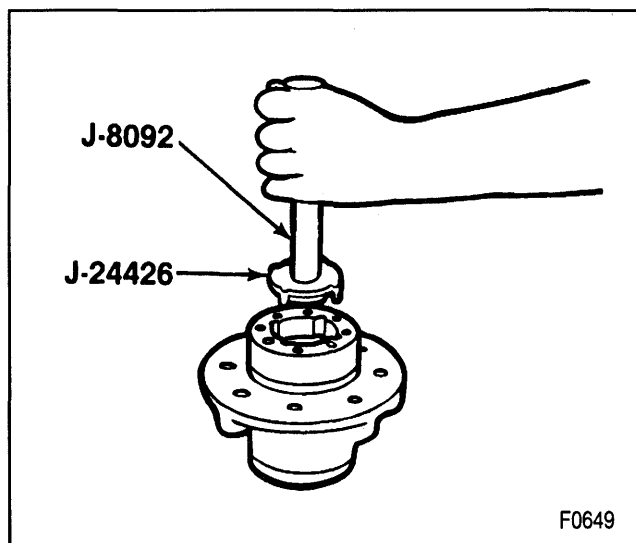
- Old sealing compound from the oil seal bore in the hub.

- Bearing assemblies in a solvent using a stiff brush to remove the old lubricant. Dry the bearings with compressed air. Do not spin them.



F0648

Figure 22—Removing or Installing Bearing Adjusting Nut



F0649

Figure 23—Removing or Installing the Outer Bearing Cup

- Lubricant from the axle housing and inside the hub.
- Gasket material from the hub and axle shaft.



Inspect

- Bearings for wear, chipped edges or other damage. Check for flat or rough spots on the rollers.
- Cups for pits and cracks.
- Replace parts as necessary.



Install or Connect (Figure 23)

Tools Required:

- J 8092 Driver Handle
- J 8608 Pinion Bearing Cup Installer
- J 24426 Outer Wheel Bearing Cup Installer
- J 24427 Inner Wheel Bearing Cup Installer
- J 24428 Axle Shaft Seal Installer

- Outer bearing cup into the hub.
 - Drive the cup into the hub using J 8092 and J 8608. Be sure J 8608 is installed upside down on J 8092 so that the chamfer does not contact the bearing cup. Drive the cup beyond the retaining ring groove.
- Retaining ring into the groove.
 - Drive the cup back onto the retaining ring using J 24426.
- Inner bearing cup using J 8092 and J 24427.
 - Drive the cup into place until it is seated against the hub shoulder.
- Inner bearing.
- New oil seal using J 24428.
- Hub and drum assembly.
- Outer bearing.



Adjust

- Bearing preload. Refer to "Bearing Adjustment."
- Axle shaft.

NON-DEMOUNTABLE TYPE DRUM REPLACEMENT

Construction of this drum and hub assembly does not allow replacement with the hub assembly installed on the vehicle.



Remove or Disconnect

- Raise the vehicle on a hoist and support with suitable safety stands.
- Hub and drum assembly. Refer to "Hub and Drum Assembly Replacement."
 - Retaining bolts, stud nuts, or wheel studs.
 - Separate the drum, hub, and oil deflector.
 - Press the wheel studs out of the drum. Replace parts as necessary.



Install or Connect

- Drum to the hub.
 - Make certain that the drain holes are in alignment.

- Oil deflector to the drum.
 - Apply a light coating of sealing compound to the oil deflector contact surface.
- Retaining bolts, stud nuts, or wheel studs.
 - Press the wheel studs into the drum.

WHEEL BOLT REPLACEMENT

Wheel bolts are serrated and may also be swaged in place; however, replacement procedure remains the same for both types of installation. Press the wheel bolts out of the hub flange, then press new wheel bolts into place, making sure of a tight fit. When replacing all of the wheel bolts, make sure that the hub oil deflector is in position under the wheel bolt heads.

BEARING ADJUSTMENT

Make sure the brakes are fully released and do not drag. Check the wheel bearing play by grasping the tire at the top and pulling and pushing back and forth, or by using a pry bar under the tire. If the wheel bearings are properly adjusted, movement of the brake drum in relation to the brake backing plate will be barely noticeable and the wheel will turn freely. If the movement is excessive, adjust the bearings.



Remove or Disconnect (Figure 21 and 24)

Tool Required:

- J 2222-C Wheel Bearing Nut Wrench

- Raise the vehicle until the wheel is free to spin.
- Axle shaft. Refer to "Axle Shaft Replacement."
 - Be sure the keyway, threads, and adjusting nut are clean and free of chips, burrs, and shavings.
 - Retaining ring.

NOTICE: Refer to "Notice" on page 4B1-1.

- Key.



Tighten

- Adjusting nut to 68 N·m (50 lbs. ft.) while rotating hub and drum assembly (figures 24 and 25).

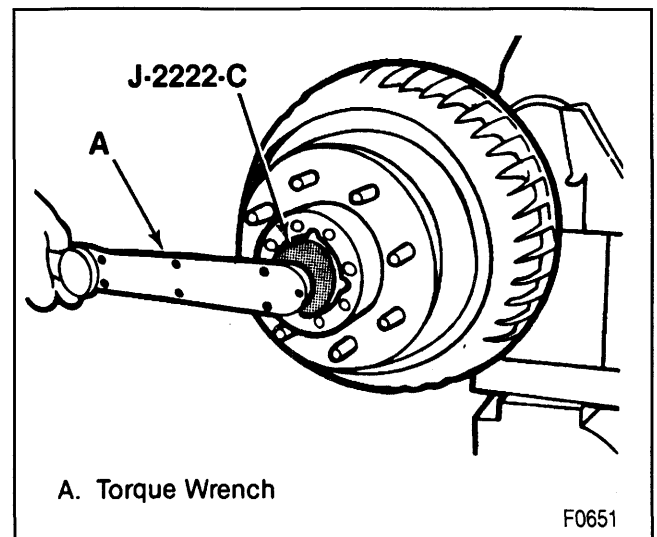


Figure 24—Tightening the Adjusting Nut

4B1-16 REAR AXLE

- Inner bearing roller assembly must be seated against spindle shoulder.



Adjust

- Nut. If adjusting nut slot is not aligned with keyway, back the nut off until just loose, but not more than one slot of the lock or the axle spindle using J 2222-C. Align the adjusting nut slot with the keyway in the axle spindle.



Install or Connect (Figure 23)

1. Key.
 - Key into the keyway and adjusting nut slot.
2. Retaining ring.
 - Be sure the retaining ring is seated.
3. Axle shaft. Refer to "Axle Shaft Replacement."

PINION OIL SEAL/COMPANION FLANGE REPLACEMENT

The pinion oil seal and the companion flange may be replaced with the carrier assembly installed in the vehicle.



Remove or Disconnect

Tools Required:

J 8614-01 Companion Flange Holder

J 8614-02 Companion Flange Remover

- Raise the vehicle on a hoist and support with safety stands.
1. Propeller shaft. Refer to SECTION 4A.
 - Tie the propeller shaft to a frame rail or crossmember.



Important

- Scribe a line on the pinion shaft, pinion nut, and companion flange to be used as a guide for reinstallation (figure 16).
2. Nut using J 8614-01 (figure 17).
 - Have a drain pan ready to catch the oil.

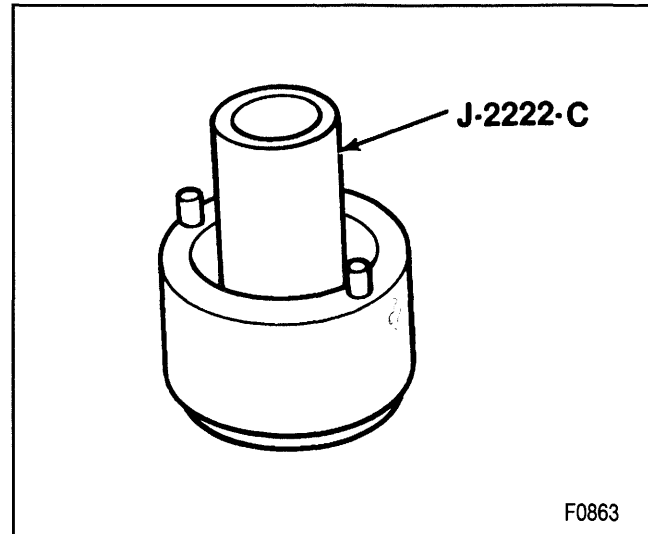


Figure 25—Wheel Bearing Nut Wrench

3. Flange using J 8614-02 (figure 18).
4. Oil seal.
 - Pry the oil seal from the bore. Do not damage the machined surfaces. Thoroughly clean foreign material from the contact area.
 - Replace parts as necessary.



Install or Connect

Tools Required:

J 8614-01 Companion Flange Holder

J 24384 Pinion Oil Seal Installer (Dana 10 1/2-inch ring gear axle).

1. Oil seal into the bore using J 24384.
 - Lubricate the cavity between the new seal lips with a high melting point bearing lubricant.
2. Flange using J 8614-01.
 - Use scribed marks for reinstallation.
3. Nut, using J 8614-01 (figure 17).
 - Use scribe mark as an installation reference.
4. Propeller shaft. Refer to SECTION 4A.

FULL FLOATING AXLE (11-INCH RING GEAR)

The following rear axle procedures apply to vehicles equipped with rear drum or disc brakes. If the model to be serviced has rear disc brakes, refer to SECTION 5B2 for the appropriate brake-related procedures.

AXLE SHAFT REPLACEMENT



Remove or Disconnect (Figures 26 and 27)

1. Bolts. If the vehicle is equipped with rear disc brakes the axle cap must also be removed (figure 27).
 - A. Tap the axle shaft lightly with a soft-faced hammer to loosen the gasket.
 - B. Grip the rib on the axle shaft with a locking plier and twist to start shaft removal.
2. Axle shaft from the tube.



Clean

- Axle shaft. Remove old RTV or gasket.
- Outside face of the hub assembly.



Inspect

- Shaft for abnormal wear at areas that ride in bearings.
 - Shaft to see if it is bent.
 - Shaft splines for chips, burrs, cracking, or if they are worn.
- Replace if any of the above conditions exist.



Install or Connect (Figures 26 and 27)

1. Axle shaft with gasket (if used) or RTV applied.
 - A. Be sure the shaft splines mesh into the differential side gear.

B. Align the axle shaft holes with the hub holes.

NOTICE: Refer to "Notice" on page 4B1-1.

2. Bolts (figures 26 and 27).



Tighten

- Bolts to 203 N-m (150 lbs. ft.).

HUB AND DRUM ASSEMBLY REPLACEMENT

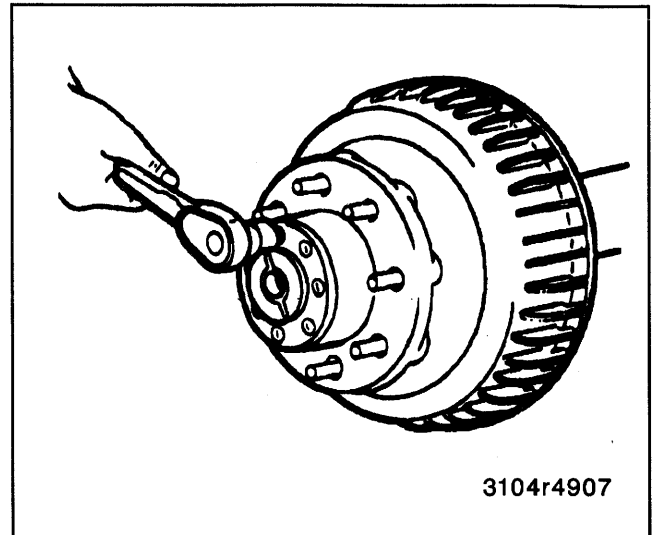


Remove or Disconnect (Figures 27 and 28)

Tool Required:

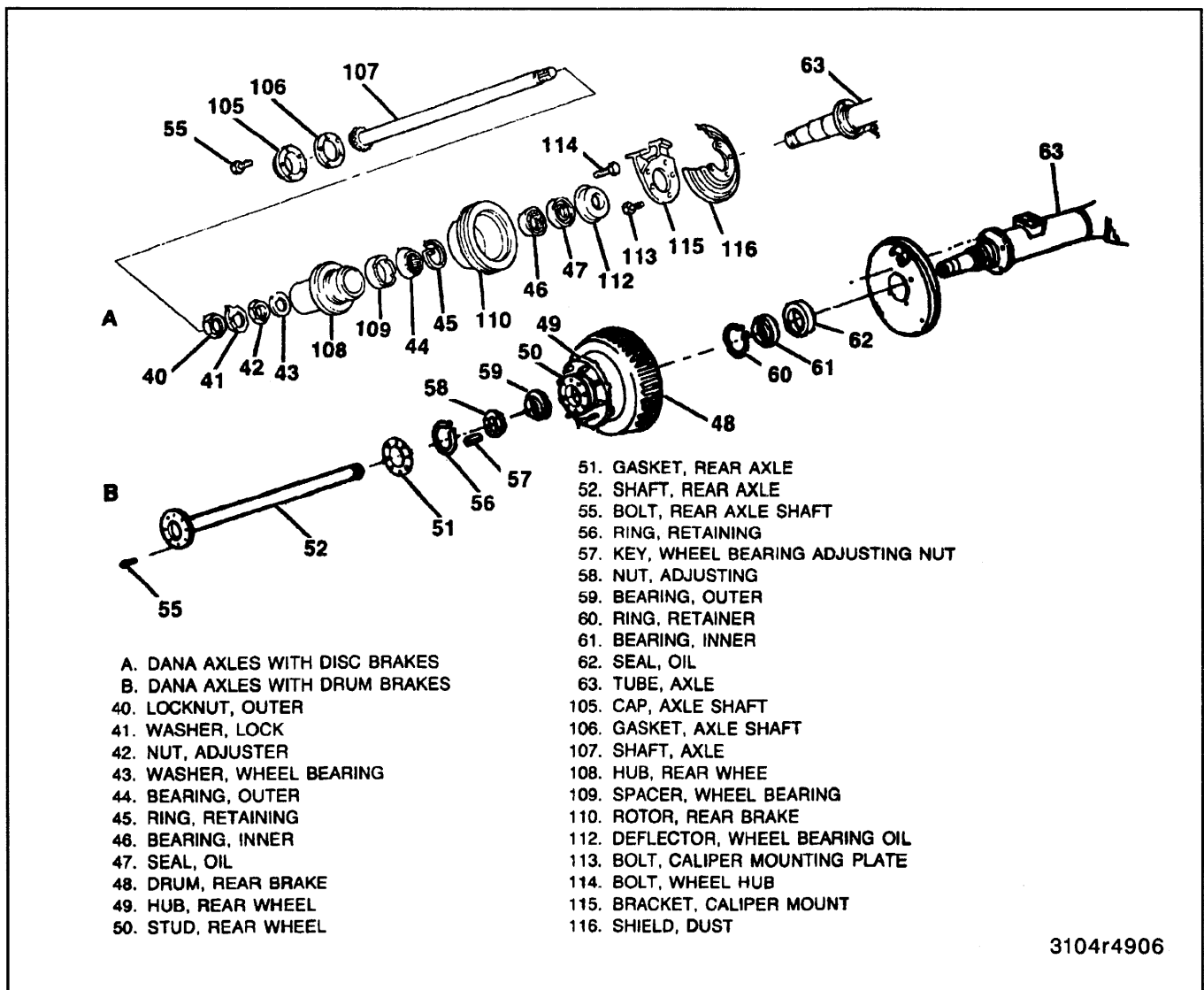
J 2222-C Wheel Bearing Nut Wrench

- Raise the vehicle until the wheel is free to rotate.
1. Tire and wheel assembly.
 2. Axle shaft. Refer to "Axle Shaft Replacement."



3104r4907

Figure 26—Removing or Installing Flange-to-Hub Bolts



3104r4906

Figure 27—Full-Floating Axle, Wheel End Components

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3. Nut using J 2222-C, or retaining ring. Refer to figure 28.
4. Lock or key.
5. Adjusting nut. Refer to figure 28.
6. Washer.
7. Hub and drum, or hub and rotor.



Inspect

- For any worn or damaged parts. Replace any part which appears defective.



Install or Connect (Figures 27 and 28)

NOTICE: For steps 3 and 5, refer to "Notice" on page 4B1-1.

Tool Required:

J 2222-C Wheel Bearing Nut Wrench

1. Hub and drum, or hub and rotor to the tube.
 - Be sure the bearings and the oil seal are positioned properly.
 - Apply a light coat of high melting point EP bearing lubricant to the contact surfaces and the outside of the axle tube. Refer to SECTION 0B.
2. Washer.
 - Engage tang in keyway.
3. Adjusting nut. Refer to figure 28.



Tighten

- Adjusting nut to specifications (at the end of this section) while turning the hub.
4. Lock or key.
 - Bend the tang to the flat of the adjusting nut or insert the key.
5. Nut or retaining ring. Refer to figure 28.



Tighten

- Nut to 88 N·m (65 lbs. ft.).
6. Axle shaft. Refer to "Axle Shaft Replacement".
7. Tire and wheel assembly.
 - Lower the vehicle.

WHEEL BEARING/CUP REPLACEMENT



Remove or Disconnect (Figures 27 and 29)

Tools Required:

J 8092 Drive Handle

J 24426 Outer Wheel Bearing Cup Installer

- Raise the vehicle until the wheels are free to rotate.
1. Axle shaft. Refer to "Axle Shaft Replacement."
 2. Hub and drum assembly. Refer to "Hub and Drum Assembly Replacement."
 3. Inner bearing and oil seal.
 - A. Lay the drum on a flat surface with a shop towel to catch the bearing and seal.
 - B. Use a drift to remove the bearing cup and seal.
 4. Retaining ring.
 - Use snap ring pliers to remove the ring.

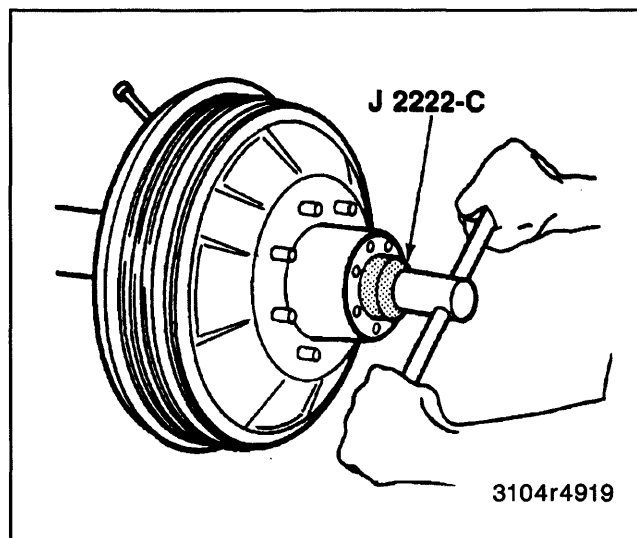


Figure 28—Removing or Installing Bearing Adjusting Nut

5. Outer bearing using J 8092 with J 24426 (figure 29).
 - Drive the bearing and cup from the hub.



Clean

- Old sealing compound from the oil seal bore in the hub.
- Bearing assemblies in a solvent using a stiff brush to remove the old lubricant. Dry the bearings with compressed air. Do not spin them.
- Lubricant from the axle tube and inside the hub.
- Gasket material (if used) from the hub and axle shaft.



Inspect

- Bearings for wear, chipped edges or other damage. Check for flat or rough spots on the rollers. Refer to wheel bearing diagnosis illustrations in this section (figures 2 and 3).
- Cups for pits and cracks.

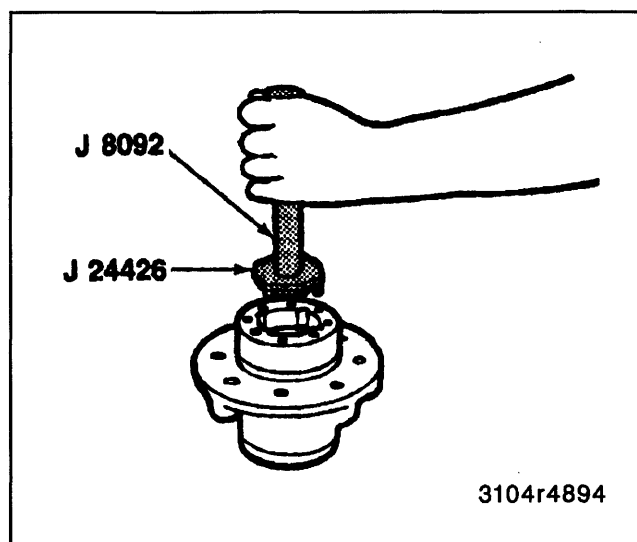


Figure 29—Removing the Outer Bearing and Cup

- Oil seal for wear or roughness. Replace parts as necessary.
- Pack inner and outer bearings with wheel bearing lubricant GM P/N 1051344. Refer to SECTION 0B.

Install or Connect (Figures 27, 30 through 32)

Tools Required:

- J 8092 Driver Handle
- J 8608 Outer Pinion Bearing Cup Installer
- J 24426 Outer Wheel Bearing Cup Installer
- J 24427 Inner Wheel Bearing Cup Installer
- J 39114-A Axle Shaft Seal Installer

- Outer bearing cup into the hub.
 - Drive the cup into the hub using J 8092 and J 8608 (figure 30). Drive the cup beyond the retaining ring groove.

Important

- Be sure J 8608 is installed upside down on J 8092 so that the chamfer does not contact the bearing cup.
- Retaining ring into the groove.
 - Drive the cup back onto the retaining ring using J 24426 (figure 31).
 - Inner bearing cup using J 8092 and J 24427 (figure 32).
 - Drive the cup into place until it is seated against the hub shoulder.
 - Inner bearing.
 - New oil seal using J 39114-A (figure 33).
 - Hub and drum.
 - Outer bearing.

Adjust

- Bearing preload. Refer to "Bearing Adjustment."
- Axle shaft.

NON-DEMOUNTABLE TYPE DRUM REPLACEMENT

Construction of the non-demountable type drum and hub assembly is such that replacement cannot be done with the hub assembly installed on the vehicle.

Remove or Disconnect

- Raise the vehicle.
- Hub and drum assembly. Refer to "Hub and Drum Assembly Replacement."
 - Retaining bolts, stud nuts or wheel studs.
 - Separate the drum, hub, and oil deflector (if equipped).
 - Press the wheel studs out of the drum. Replace parts as necessary.

Install or Connect

- Drum to the hub.
 - Make certain the drain holes are aligned.
- Oil deflector (if equipped) to the drum.
 - Apply a light coating of sealing compound to the oil deflector contact surface.
- Retaining bolts, stud nuts or wheel studs.
 - Press the wheel studs into the drum.

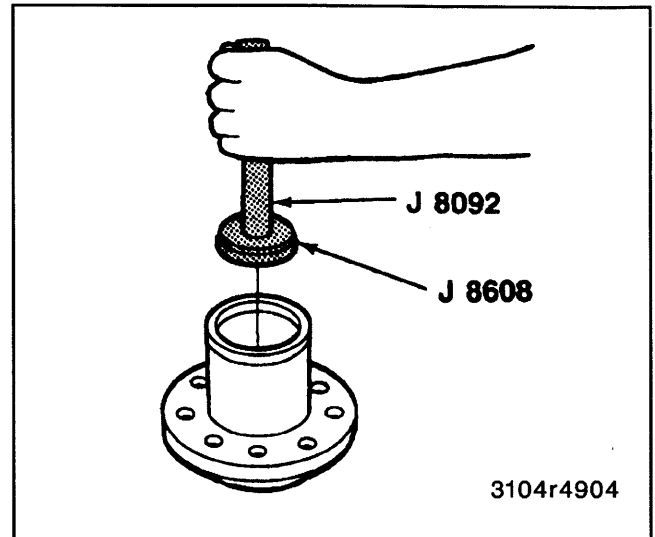


Figure 30—Installing Outer Bearing Cup

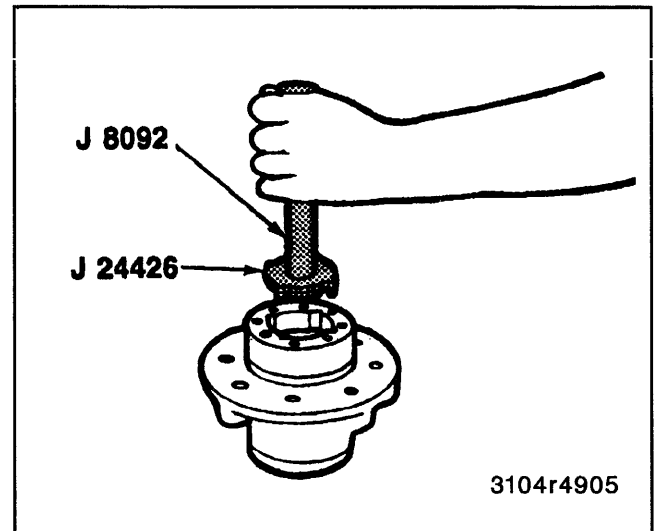


Figure 31—Seating Outer Bearing Cup onto Retaining Ring

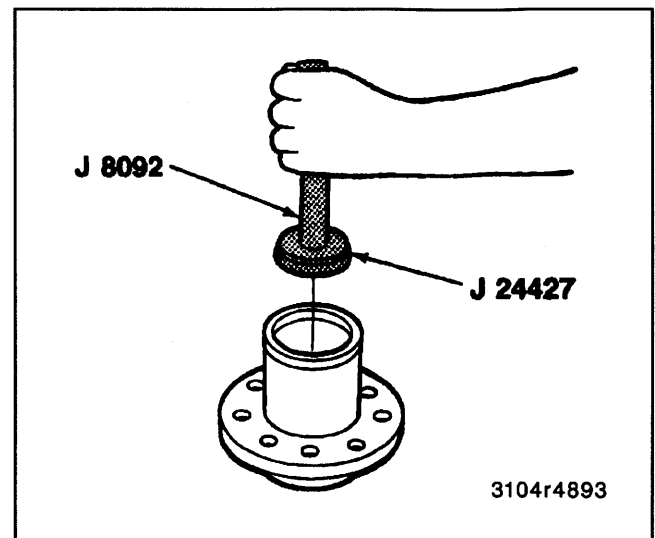


Figure 32—Installing Inner Bearing Cup

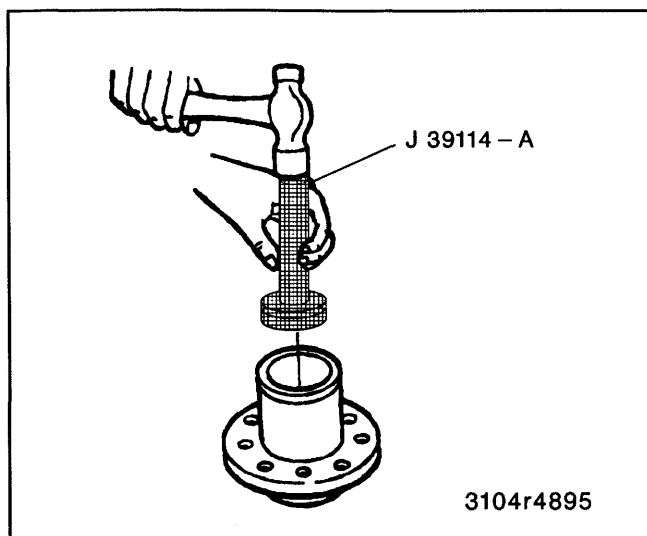


Figure 33—Installing Oil Seal into Hub

WHEEL STUD REPLACEMENT

Wheel studs are serrated and may also be swaged in place; however, replacement procedure remains the same for both types of installation. Press the wheel studs out of the hub flange, then press new wheel studs into place, making sure of a tight fit. When replacing all of the wheel studs be sure that the hub oil deflector (if equipped) is in position under the wheel stud heads. Refer to figure 34.

WHEEL BEARING ADJUSTMENT

- Make sure the brakes are fully released and do not drag.
- Check the wheel bearing play by grasping the tire at the top and pulling and pushing back and forth, or by using a pry bar under the tire. If the tapered roller bearings are properly adjusted, movement of the brake drum in relation to the brake flange plate will be barely noticeable and the wheel will turn freely. If the movement is excessive, adjust the bearings.

REAR AXLES WITH DRUM BRAKES

Remove or Disconnect (Figure 27)

Tool Required:
J 2222-C Wheel Bearing Nut Wrench

- Raise the vehicle until the wheel is free to spin.
1. Axle shaft. Refer to "Axle Shaft Replacement."
 - Be sure the keyway, threads and adjusting nut are clean and free of chips, burrs and shavings.
 2. Retaining ring.
 3. Rear wheel bearing axle adjusting nut key.

NOTICE: Refer to "Notice" on page 4B1-1.

4. Adjusting nut.

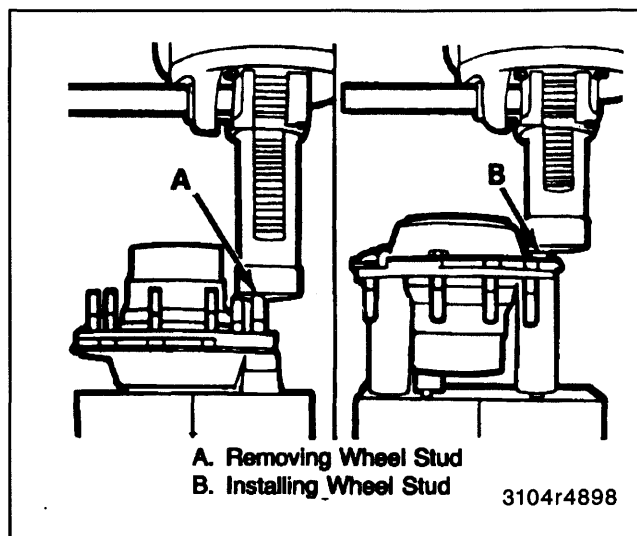


Figure 34—Wheel Stud Replacement

Tighten

- Adjusting nut to 68 N·m (50 lbs. ft.). Tighten with J 2222-C while rotating the hub assembly, making certain the bearing cones are seated and in contact with the spindle shoulder.

Adjust

- Back off the adjusting nut and retighten to 47 N·m (35 lbs. ft.) while hub is rotated.
- Back off the adjusting nut 135 to 150 degrees.

Install or Connect

1. Lock washer.
 - Bend one tang of the retaining washer over a flat of the adjusting nut, 30 degrees minimum.

NOTICE: Refer to "Notice" on page 4B1-1.

2. Outer retaining nut.

Tighten

- Outer retaining nut to 88 N·m (65 lbs. ft.) minimum.

Adjust

- Final bearing adjustment is 0.025 to 0.25 mm (0.001 to 0.010 inch).
 - Bend one tang of the retaining washer over a flat of the outer nut, 60 degrees minimum.
3. Wheel bearing grease into bearings.
 4. Axle shaft. Refer to "Axle Shaft Replacement."

Install or Connect (Figure 27)

1. Key into adjusting nut slot.
 - If slot is in alignment with keyway in axle spindle, back nut off a slight amount, but not more than one slot, to align key.

2. Snap ring to spindle end. Be sure ring is seated.
3. Axle shaft. Refer to "Axle Shaft Replacement."

REAR AXLES WITH DISC BRAKES

Remove or Disconnect (Figure 27)

Tool Required:

J 2222-C Wheel Bearing Nut Wrench

- Raise the vehicle until the wheel is free to spin.
1. Axle shaft. Refer to "Axle Shaft Replacement."
 - Be sure the keyway, threads and adjusting nut are clean and free of chips, burrs and shavings.
 2. Retaining ring.
 3. Rear wheel bearing axle adjusting nut key.

NOTICE: Refer to "Notice" on page 4B1-1.

4. Adjusting nut.

Tighten

- Adjusting nut to 68 N.m (50 lbs. ft.). Tighten with J 2222-C while rotating the hub assembly, making certain the bearing cones are seated and in contact with the spindle shoulder.

Adjust

- Back off the adjusting nut and retighten to 47 N.m (35 lbs. ft.) while hub is rotated.
- Back off the adjusting nut 135 to 150 degrees.

Install or Connect

1. Lock washer.
 - Bend one tang of the retaining washer over a flat of the adjusting nut, 30 degrees minimum.

NOTICE: Refer to "Notice" on page 4B1-1.

2. Outer retaining nut.

Tighten

- Outer retaining nut to 88 N.m (65 lbs. ft.) minimum.

Adjust

- Final bearing adjustment is 0.025 to 0.25 mm (0.001 to 0.010 inch).
 - Bend one tang of the retaining washer over a flat of the outer nut, 60 degrees minimum.
3. Wheel bearing grease into bearings.
 4. Axle shaft. Refer to "Axle Shaft Replacement."

PINION OIL SEAL/PINION FLANGE REPLACEMENT

The pinion oil seal and the pinion flange may be replaced with the carrier assembly installed in the vehicle.

Remove or Disconnect (Figures 22 through 24)

Tool Required:

J 8614-01 Pinion Flange Holder and Remover

- Raise the vehicle.
1. Propeller shaft. Refer to SECTION 4A.

Important

- Scribe a line on the pinion stem, pinion nut and pinion flange to be used as an installation guide (figure 12).
2. Nut using J 8614-01 (figure 23).
 3. Flange using J 8614-01 (figure 24).
 - Use the special nut and forcing screw to remove the flange.
 4. Oil seal.
 - Pry the oil seal from the bore. Do not damage the machined surfaces.
 - Thoroughly clean foreign material from the contact area.

Inspect

- Oil seal mating surfaces for any burrs which may cause seal failure.
- Flange deflector for any abnormality such as cracking or distortion.

Replace any part which shows any of the above conditions.

Install or Connect (Figure 35)

Tools Required:

J 8614 Pinion Flange Holder and Remover

J 24384 Pinion Oil Seal Installer
(Dana 10 1/2-inch ring gear axle)

1. Oil seal into the bore using J 24384 (figure 36).
 - Lubricate the inside diameter of the new oil seal with extreme pressure lubricant such as GM P/N 9985038.

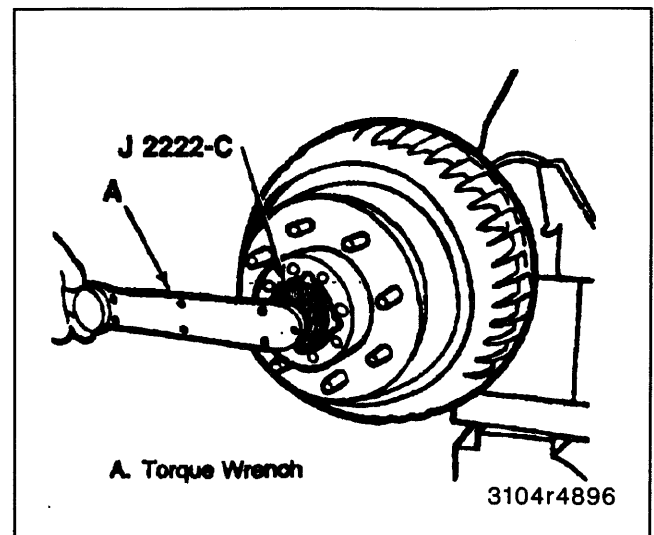


Figure 35—Tightening the Adjusting Nut

4B1-22 REAR AXLE

- Pack the cavity between the pinion stem, pinion flange and pinion nut washer with a non-hardening sealer such as Permatex® Type A or equivalent.
2. Flange using J 8614 (figure 23).
 - Use marks scribed previously for installation.
 3. Nut, using J 8614 (figure 23).
 - Use marks scribed previously for installation.
 4. Propeller shaft. Refer to SECTION 4A.

REAR AXLE ASSEMBLY REPLACEMENT

↔ Remove or Disconnect

- Raise the vehicle and place jack stands under the frame side rails for support.
 - Drain the lubricant from the axle housing.
1. Propeller shaft. Refer to SECTION 4A.
 2. Tire and wheel assembly.
 3. Brake drum or hub and drum.
 4. Parking brake cable from the lever and at the brake flange plate. Refer to SECTION 5F.
 5. Hydraulic brake pipes from the connectors. Refer to SECTION 5.
 6. Shock absorbers from the axle brackets.
 7. Vent hose from the axle vent fitting.
 8. Height-sensing and brake proportioning valve linkage (if equipped).
 - Support the assembly with a hydraulic floor jack.
 9. Nuts and washers from the U-bolts.
 10. U-bolts, spring plates, and spacers from the axle assembly.
 - Lower the jack and the axle assembly.

→← Install or Connect

1. Axle assembly under the vehicle.
 - Align the axle assembly with the springs.
2. Spacers, spring plates, and U-bolts to the axle assembly.
 - Raise the axle assembly.
3. Washers and nuts to the U-bolts.
 - Thread the nuts on firmly.
 - Adjust alignment of axle.
4. Height-sensing and brake proportioning valve linkage (if equipped).

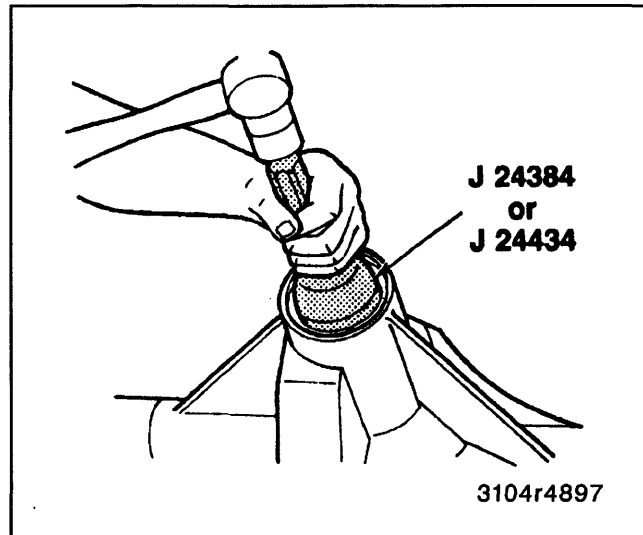


Figure 36—Installing Pinion Oil Seal into Bore

5. Vent hose to the axle vent fitting.
6. Shock absorbers to the axle brackets.
7. Hydraulic brake lines to the connectors. Refer to SECTION 5.
8. Parking brake cable to the lever and the flange plate. Refer to SECTION 5F.
9. Tire and wheel assembly.
10. Brake drum or hub and drum.

NOTICE: Refer to "Notice" on page 4B1-1.

11. Propeller shaft. Refer to SECTION 4A.

⌚ Tighten

- All fasteners. Refer to "Specifications" at the rear of this section.
12. Axle lubricant. Fill to the filler plug hole level. Refer to SECTION 0B.

! Important

- Bleed the brake system, check operation and adjust if necessary. Refer to SECTION 5A.
- Remove jack stands and lower vehicle.
- Check axle and brake operation.
- Check for fluid leaks and road test the vehicle.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Item	8 1/2" Ring Gear—Semi Floating Axle		9 1/2" Ring Gear—Semi Floating Axle		DANA 9 3/4"—10 1/2" Ring Gear Axle—Full Floating		DANA 11" Ring Gear Axle—Full Floating	
	N·m	Lbs. Ft.	N·m	Lbs. Ft.	N·m	Lbs. Ft.	N·m	Lbs. Ft.
Axle Shaft to Hub Bolts	—	—	—	—	156	115	203	150
Brake Backing Plate	47	35	142	105	142	105	244	180
Carrier Cover	27	20	27	20	47	35	47	35
Filler Plug	34	25	24	18	34	25	34	25
Lock Screw	34	25	34	25	—	—	—	—

LUBRICATION

Item	8 1/2" Ring Gear—Semi Floating Axle		9 1/2" Ring Gear—Semi Floating Axle		DANA 9 3/4"—10 1/2" Ring Gear Axle—Full Floating		DANA 11" Ring Gear Axle—Full Floating	
	Liters	Pints	Liters	Pints	Liters	Pints	Liters	Pints
Capacity	2.0	4.2	2.6	5.5	2.6	5.5	4.0	8.2

WHEEL BEARING ADJUSTMENT VALUES*

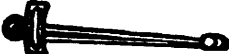
Axle Make	Rear Brake Type	Ring Gear Size	Bearing Adjusting Nut Torque (While Rotating Wheel)		Adjusting Nut Back-Off	Outer Locknut Torque	
			N·m	Lbs. Ft.		N·m	Lbs. Ft.
Dana	Drum	9 3/4" and 10 1/2"	68	50	**	—	—
Saginaw	Drum	10 1/2"	68	50	**	—	—
Dana	Disc	10 1/2"	68	50	**	88	65
Dana	Disc/Drum	11"	68	50	***	88	65

* Resulting end play should be 0.0254 to 0.254 mm (0.001 to 0.010 inch).

** Back off until loose. Rotate nut up against bearing cone shoulder (zero torque).

*** Back off the nut and while rotating the hub tighten to 54 N·m (40 lbs. ft.). Then back off nut 135 to 150 degrees. Final end play 0.025 to 0.25 (0.001 to 0.010 inch).

SPECIAL TOOLS

- | | |
|---|--|
| 1.  J 6627-A | 12.  J 23689 |
| 2.  J 8092 | 13.  J 21128 |
| 3.  J 5853-B | 14.  J 23690 |
| 4.  J 8614-01 | 15.  J 29709 |
| 5.  J 2222-C | 16.  J 29713 |
| 6.  J 24426 | 17.  J 22388 |
| 7.  J 24427 | 18.  J 22804-1 |
| 8.  J 8608 | 19.  J 22836 |
| 9.  J 24384 | 20.  J 29712 |
| 10.  J 39114 - A | |
| 11.  J 22349 | |

1. WHEEL STUD REMOVER
2. DRIVER HANDLE
3. TORQUE WRENCH
4. COMPANION FLANGE HOLDER
5. WHEEL BEARING NUT WRENCH
6. OUTER WHEEL BEARING CUP INSTALLER
7. INNER WHEEL BEARING CUP INSTALLER
8. PINION BEARING CUP INSTALLER
9. DANA PINION SEAL INSTALLER
10. AXLE SHAFT SEAL INSTALLER
11. PINION BEARING CUP INSTALLER

12. AXLE SHAFT BEARING REMOVER (LARGE SHAFT)
13. AXLE SHAFT AND PINION SEAL INSTALLER
14. AXLE SHAFT BEARING INSTALLER
15. AXLE SHAFT BEARING INSTALLER
16. AXLE SHAFT BEARING INSTALLER (9 1/2-INCH)
17. PINION OIL SEAL INSTALLER (9 1/2-INCH)
18. PINION OIL SEAL SPACER
19. PINION SEAL INSTALLER (8 1/2-INCH)
20. AXLE SHAFT BEARING REMOVER (9 1/2-INCH)

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SECTION 4C

FRONT AXLE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The front axle on four-wheel drive model vehicles has a central disconnect feature that, under most conditions, allows shifting into and out of four-wheel drive when the vehicle is in motion. It is engaged by an electronically-activated thermal actuator.

The thermal actuator contains a coil, fluid, and a plunger. When the coil is heated, the liquid changes to a gas and extends the plunger, which engages the front axle. To disengage, the gas must cool to a liquid.

The axle uses a conventional ring and pinion gear set to transmit the driving force of the engine to the wheels. The differential allows the wheels to turn at different

rates of speed while the axle continues to transmit the driving force. This prevents tire scuffing when going around corners and premature wear on internal axle parts. The ring and pinion set and the differential are contained within an aluminum carrier. The axle identification number is located on a tag attached to the right axle tube.

The drive axles are completely flexible assemblies consisting of inner and outer constant velocity (CV) joints protected by thermoplastic boots and connected by an axle shaft.

DIAGNOSIS OF FRONT AXLE

FRONT AXLE NOISE DIAGNOSIS

Any gear-driven unit produces a certain amount of noise that is normal and cannot be eliminated by conventional repairs or adjustment. Slight noise that is heard only at a certain speed or under unusual or remote conditions is acceptable. For example, this noise tends to reach a peak at speeds from 60 to 100 km/h (40 to 60 mph) depending upon road and load conditions, or upon gear ratio and tire size, and does not indicate trouble in the axle assembly.

When an axle is suspected of being noisy, make a thorough test to determine whether the noise originates in the tires, road surface, wheel bearings, engine, transmission, propeller shaft, or axle assembly. Raising tire pressure to eliminate tire noise (although this will not silence tread noise of mud and snow tires) and listening for the noise at varying speeds and road surfaces, on drive, float, and coast conditions will help to locate the source of noise. After selecting 4H to lock the hubs, test in 2H. This removes transfer case whine.

DETERMINING THE TYPE OF NOISE

Road Noise - Some road surfaces, such as brick or rough-surfaced concrete, cause noise which may be mistaken for tire or axle noise. Driving on a different type of road, such as smooth asphalt or dirt, will quickly show whether the road surface is the cause of noise. Road noise usually is the same on drive or coast.

Tire Noise - Tire noise may easily be mistaken for axle noise. Tire noise, however, changes with different road surfaces; axle noise does not. Temporarily inflating all tires to 345 kPa (50 psi) pressure, for test purposes only will materially alter noise caused by tires but will not affect noise caused by the axle. Axle noise usually stops when coasting at speeds under 30 miles per hour; however, tire noise continues with lower tone as the vehicle speed is reduced.

Engine and Transmission Noises - To determine which unit is causing the noise, take note of approximate vehicle speeds and conditions under which the noise is most pronounced, then stop the vehicle in a quiet place to stop interfering noises. With the transmission in neutral, run the engine slowly up and down the engine speeds corresponding to the vehicle speed at which the noise was most pronounced. If a similar noise is produced with the vehicle standing still, it is caused by the engine or transmission and not the axle.

Wheel Bearing Noise - A brinelled wheel bearing causes a knock or click approximately every two revolutions of the wheel, since the bearing rollers do not travel at the same speed as the axle and wheel. With the wheels jacked up, spin the wheels by hand while listening at the hubs for evidence of a rough or brinelled wheel bearing or loose bearings.

Gear Noise - There are two basic types of gear noise. The first type is produced by broken, bent, or forcibly damaged gear teeth, is usually quite audible over the entire speed range, and presents no difficulty in diagnosis. For example, hypoid gear tooth scoring generally results from the following: insufficient lubricant, improper break-in, wrong lubricant, insufficient gear backlash, improper ring and pinion alignment, or loss of drive pinion nut torque. The scoring will progressively lead to complete erosion of the gear tooth or gear tooth pitting and then eventual fracture if the initial scoring is not corrected (figure 1). Another cause of hypoid gear fracture is extended overloading of the gear set, which will produce fatigue fracture, or shock loading, and can will result in sudden failure.

Differential pinion and side gears rarely give trouble. Common causes of differential failure are shock loading, extended overloading, and seizure of the differential pinions to the cross shaft resulting from excessive wheel spin and consequent lubrication breakdown.

The second type of gear noise pertains to the mesh pattern of the gear teeth. This form of abnormal gear noise can be recognized because it produces a cycling pitch (whine) and will be very pronounced in the speed range at which it occurs, appearing under either drive, float, or coast conditions. Gear noise tends to peak in a narrow speed range or ranges and will tend to remain constant in pitch. Bearing noise will vary in pitch with vehicle speeds.

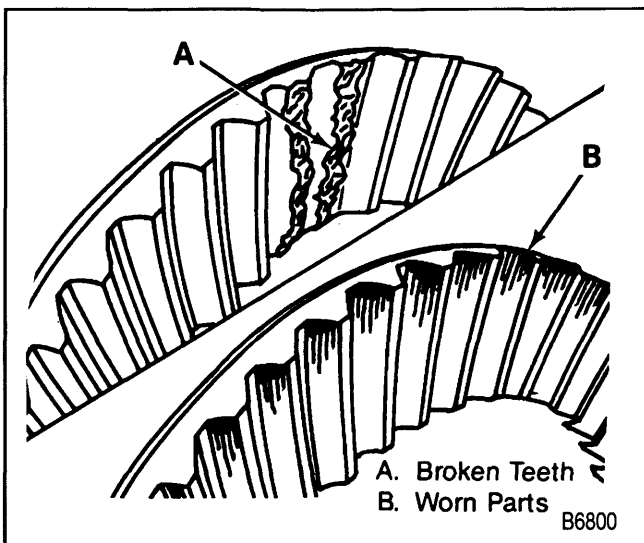


Figure 1—Causes of Gear Noise

DIAGNOSIS OF DRIVE AXLES

PROBLEM	POSSIBLE CAUSE	CORRECTION
Clicking Noise in Turns	Worn or damaged out CV joint.	Replace.
"Clunk" when Accelerating from "Coast"	1. Loose CV joint to output shaft bolts. 2. Damaged inner CV joint.	1. Tighten. 2. Replace.
Shudder or Vibration during Acceleration	1. Excessive CV joint angle. 2. Worn or damaged CV joints. 3. Sticking spider assembly (inner CV joint). 4. Sticking joint assembly (outer CV joint).	1. Repair. 2. Replace. 3. Lubricate or replace. 4. Lubricate or replace.
Vibration at Highway Speeds	1. Out of balance or out of round tires. 2. Front end out of alignment.	1. Balance or replace. 2. Align.
Front Drive Axle Leaks	1. Worn differential output seals. 2. Inspect mating area between axle tube and differential housing. 3. Inspect vent hose connector.	1. Repair seals. 2. Reseal differential housing mating area with RTV sealant. 3. Replace vent hose connector.
D0012		

DIAGNOSIS OF FOUR-WHEEL DRIVE

PROBLEM	POSSIBLE CAUSE	CORRECTION
Four-Wheel Drive Will Not Engage	1. Blown fuse. (A/C-HTR fuse). 2. Feed wire to transfer case switch open. 3. Transfer case switch faulty. 4. Wires to front axle actuator open. 5. Front axle actuator faulty. 6. Axle damaged internally.	1. Replace. 2. Repair open wire. 3. Replace transfer case switch. 4. Repair open wiring. 5. Replace axle actuator. 6. Repair as necessary. Refer to the Light Duty Truck Unit Repair Manual.
Four-Wheel Drive Will Not Disengage	1. Transfer case switch faulty. 2. Front axle actuator faulty. 3. Internal axle damage.	1. Replace switch. 2. Replace actuator. 3. Repair as necessary. Refer to the Light Duty Truck Unit Repair Manual.
Four-Wheel Drive Indicator Light Will Not Turn Off	Front axle switch faulty.	Replace front axle switch.
Four-Wheel Drive Engages But Indicator Light Will Not Come On	1. Bulb burned out. 2. Front axle switch faulty.	1. Replace. 2. Replace the switch.
D0273		

ON-VEHICLE SERVICE

SKID PLATE REPLACEMENT



Remove or Disconnect (Figure 2)

1. Screws (116).
2. Skid plate (115).



Install or Connect (Figure 2)

1. Skid plate (115).

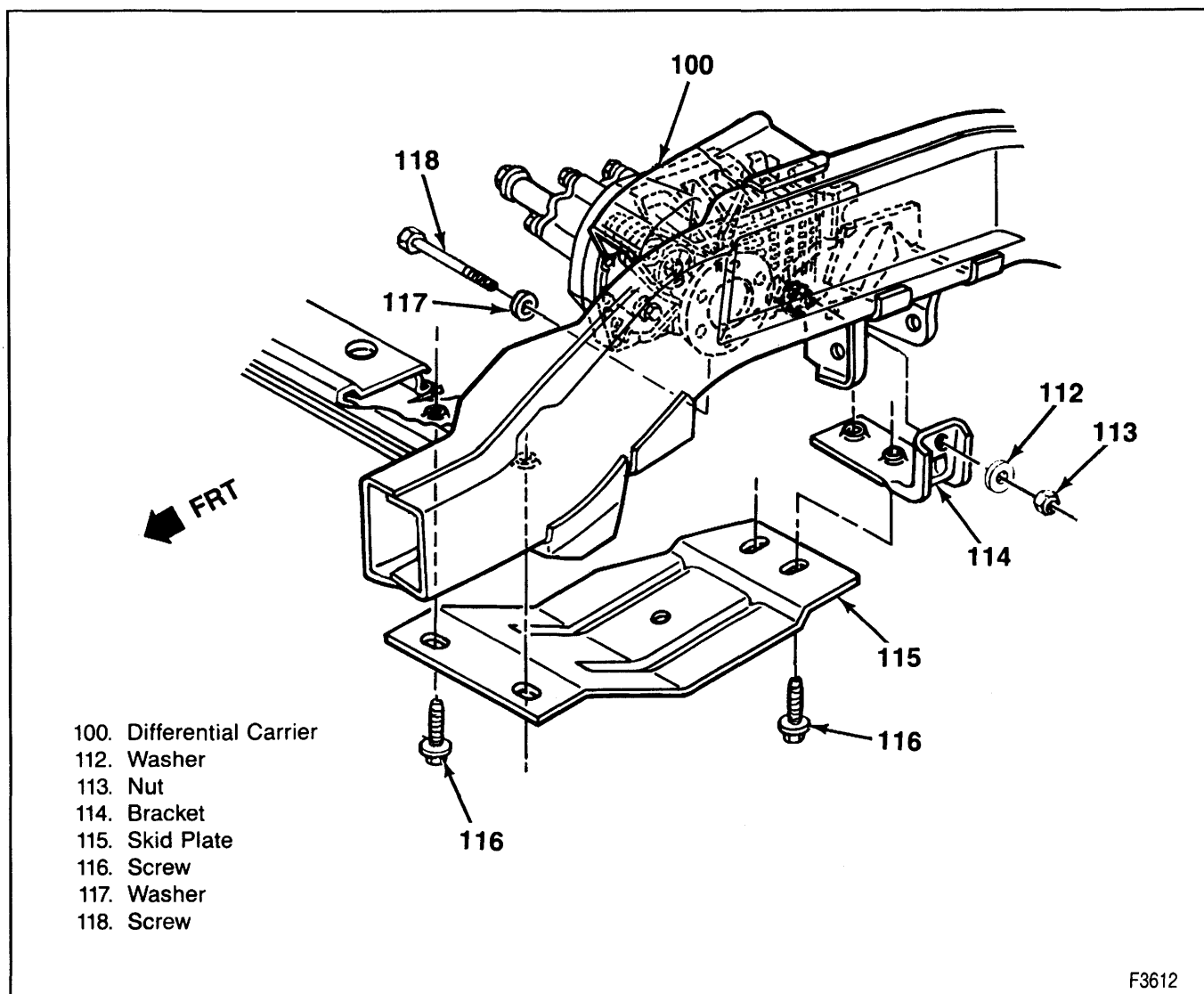
NOTICE: Refer to "NOTICE" on page 4C-1.

2. Screws (116).



Tighten

- Screws to 34 N.m (25 lbs. ft.).



DRAIN AND FILL

↔ Remove or Disconnect (Figure 3)

1. Skid plate (115), if necessary (figure 2).
2. Fill plug (26).
3. Drain plug (27) and the washer (28).

→ Install or Connect (Figure 3)

NOTICE: For steps 1 and 2, refer to "Notice" on page 4C-1.

- New lubricant. Refer to "Specifications" in this section.

1. Washer (28) and drain plug (27).



Tighten

- Plug (27) to 33 N.m (24 lbs. ft.).

2. Fill plug (26).



Tighten

- Plug (26) to 33 N.m (24 lbs. ft.).

3. Skid plate (115), if necessary (figure 2).

INDICATOR SWITCH REPLACEMENT

↔ Remove or Disconnect (Figure 3)

1. Skid plate (if equipped).
2. Connector from the indicator switch.
3. Indicator switch (11).



Install or Connect (Figure 3)

1. Indicator switch (11).
 - Coat the switch threads with sealer (GM P/N 1052942) or equivalent.
2. Connector.
3. Skid plate (if equipped).

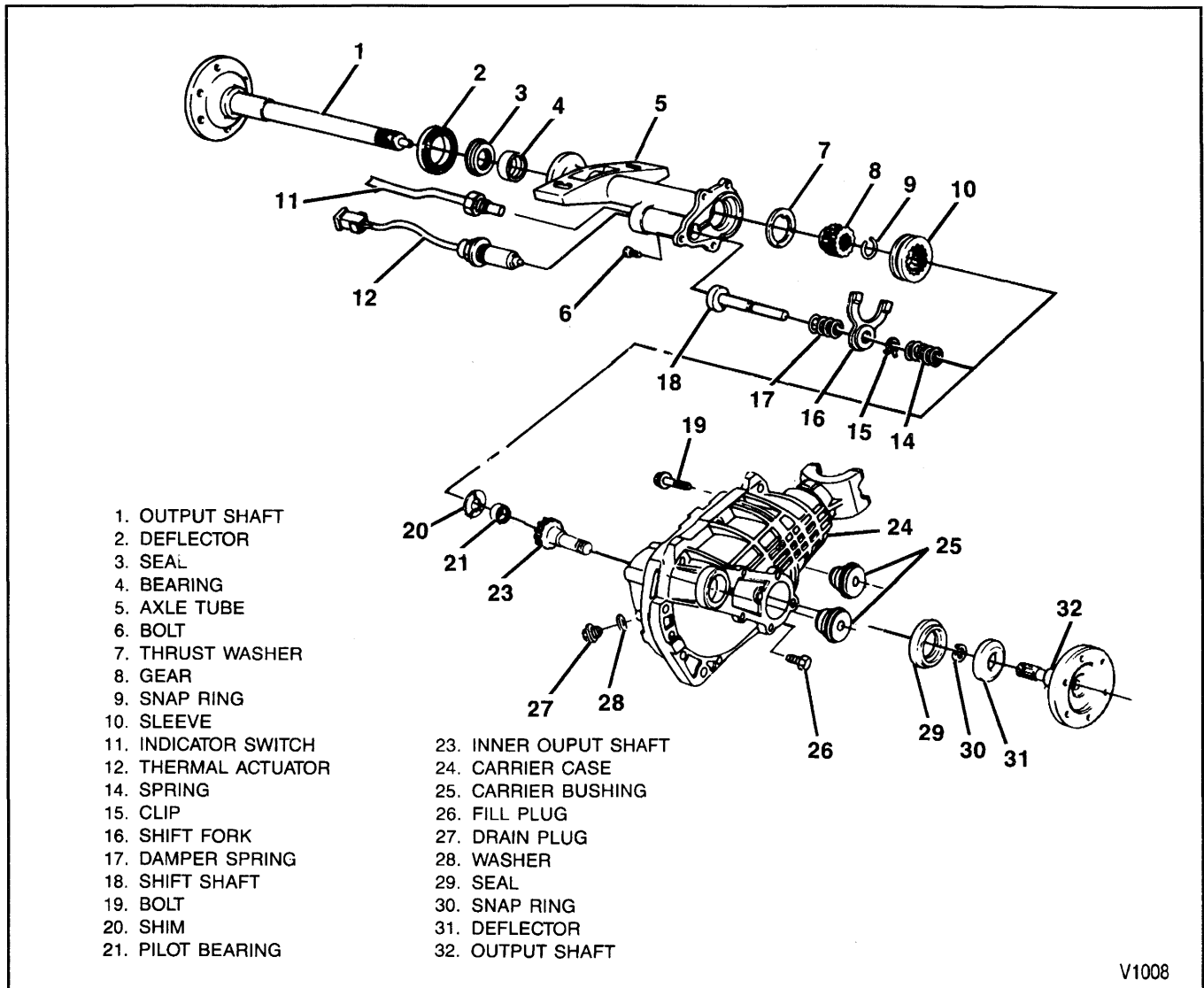


Figure 3—Front Axle Components

THERMAL ACTUATOR REPLACEMENT

↔ Remove or Disconnect (Figure 3)

1. Skid plate (if equipped).
2. Connector from the actuator.
3. Thermal actuator (12).

→ Install or Connect (Figure 3)

NOTICE: Refer to "Notice" on page 4C-1.

1. Thermal actuator (12).
 - Coat the threads with sealant (GM P/N 1052942) or equivalent.



Tighten

- Actuator to 22 N·m (16 lbs. ft.).
2. Connector.
 3. Skid plate (if equipped).

FRONT AXLE VENT HOSE REPLACEMENT

↔ Remove or Disconnect (Figure 4)

1. Skid plate (if equipped).
2. Clamp (52).
3. Hose (53) from the axle.
4. Bolt (50).
5. Clip (54).
6. Hose (53).

→ Install or Connect (Figure 4)

1. Hose (53) to the vehicle.
 - Route the same way as when removed.
 - Make sure it is free of kinks and is routed clear of sharp components.
 - Make sure the vent is not plugged.
2. Clip (54).
3. Bolt (50) and clamp (51).

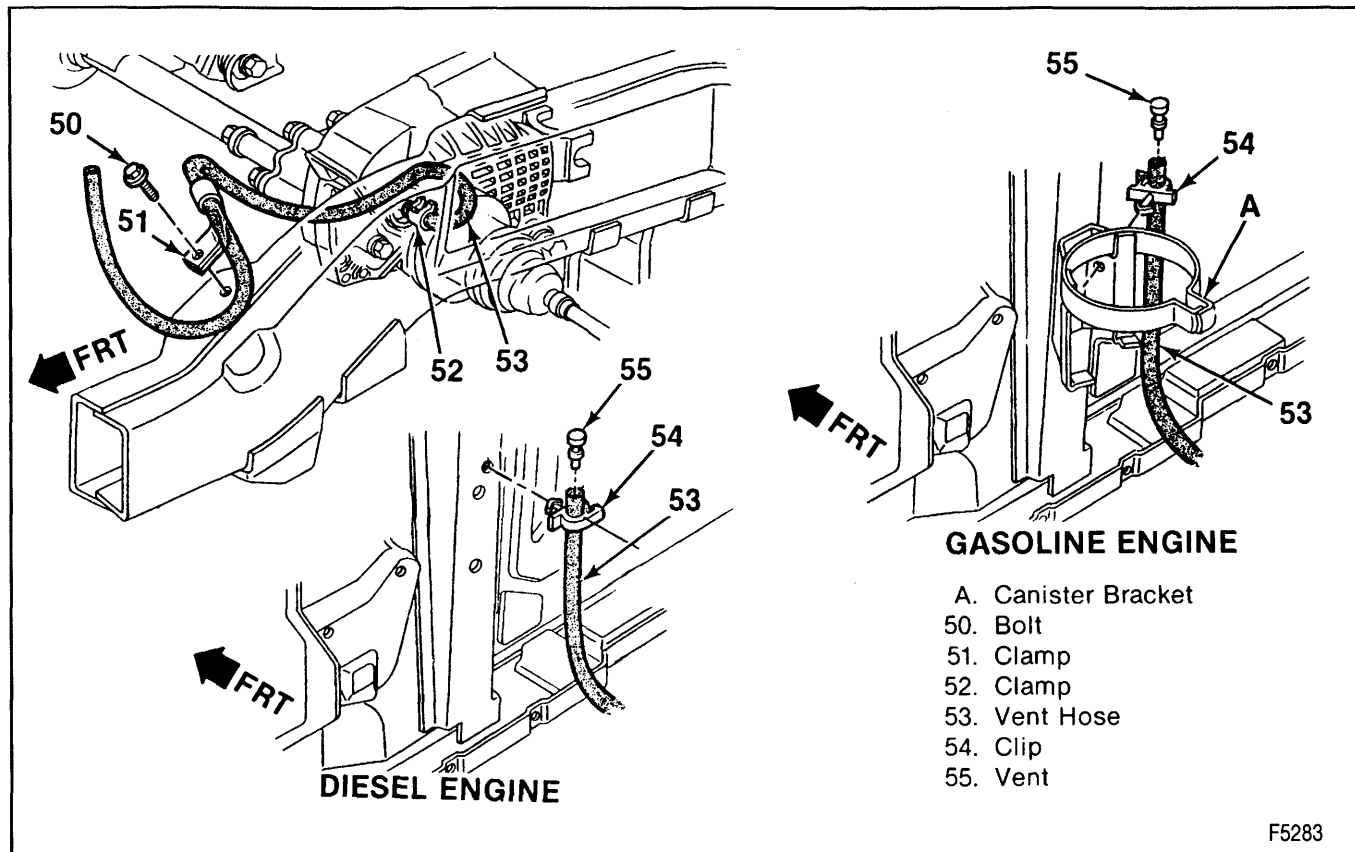


Figure 4—Vent Hose

4. Hose to the axle fitting.
5. Clamp (52).
6. Skid plate (if equipped).

DRIVE AXLE REPLACEMENT

↔ Remove or Disconnect (Figures 5 through 12)

Tools Required:

- J 28733-B Axle Remover
- J 24319-B Steering Linkage Puller
- J 8059 Snap Ring Pliers
- J 35910 Seal Clamp Tool
- J 36605 Front Knuckle Seal Installer

- Raise vehicle and support it with safety stands.
1. Wheel and tire assembly.
 - Insert a drift or large screwdriver through the brake caliper into one of the brake rotor vanes to prevent drive axle from turning (figure 6).
 2. Drive axle hub nut (203) and washer (202) (figure 5).
 - Loosen but do not remove at this time 6 bolts (200) securing inboard C/V joint drive flange to the output shaft companion flange (figure 5).

! Important

- Be careful when removing inner boot to avoid damaging it.
3. Brake pipe support bracket from upper control arm to allow extra travel of knuckle (figure 7).
 4. Cotter pin and nut from outer tie rod.

5. Separate the outer tie rod ball stud from the steering knuckle using J 24319-B (figure 8).

NOTICE: Do not attempt to disengage the joint by driving a wedge-type tool between the joint and the knuckle. This may cause seal damage.

- Push linkage to opposite side of the vehicle and secure outer tie rod up and out of the way. This will provide the needed clearance to remove the drive axle.
6. Lower shock mounting nut and bolt (figure 9).
 - Collapse the shock absorber and secure if necessary.
 7. Stabilizer shaft components as follows (figure 12):
 - Remove stabilizer shaft bushing and bracket.
 - Remove stabilizer shaft bolt, spacer, and bushings at the lower control arm.

! Important

- This is required on K2 vehicles with C6P option. (8600 lb GVW rating. Refer to option listing for vehicle). It is also required on K3 vehicles to provide needed clearance for drive axle removal.
8. Position floor stand between the spring seats and the lower control arm ball joint for maximum leverage. The weight of the vehicle is used to relieve the spring tension on the upper control arm.

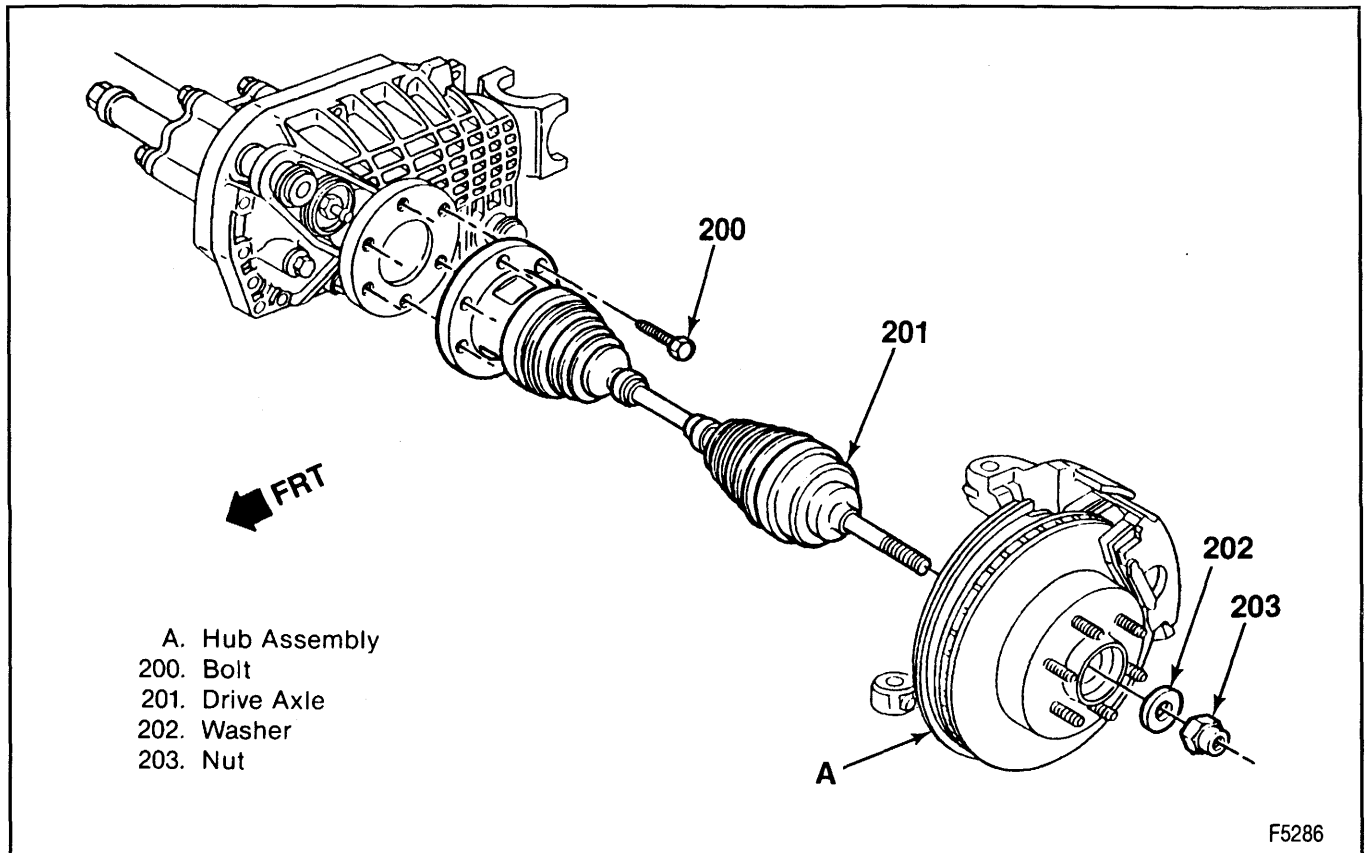


Figure 5—Drive Axle

CAUTION: The floor jack or stand must remain under the control arm spring seat while servicing the drive axle to maintain spring and control arm position. Failure to do so could result in personal injury.

9. Disconnect the cotter pin (138) from the upper control arm ball joint stud.
 - Loosen (do not remove at this time) the stud nut on the upper ball joint stud.
 - Loosen the stud from the knuckle.
10. Remove nut (139) (figure 10).
11. Stud (137) from knuckle (figure 10).
12. Nut (figure 10).



Important

- Cover the shock mounting bracket and the ball stud on the lower control arm with a shop towel to prevent possible drive axle seal damage during removal and installation.
13. Knuckle assembly using J 28733-B (or equivalent) and separate outer C/V joint splined shank from knuckle hub (figure 11).
 14. Six bolts from inboard joint flange (figure 5).
 - Support inboard end of drive axle. Move knuckle and hub assembly outward to free splined shank from hub.
 15. Drive axle from vehicle.



Important

- Wipe the wheel bearing seal area on the knuckle clean.

- Check the seal for cuts or tears.
16. Lubricate the seal lip.
 - If seal is cut or torn, inspect the wheel bearing for damage and replace the seal.
 17. Replace the seal as follows:
 - Pry old seal from knuckle and discard.
 - Lubricate the new seal lip.
 - Use J 36605 to install the seal in the knuckle.



Install or Connect (Figures 5 through 12)

NOTICE: For steps 3, 5, 8, 10, 12, 14, and 15, refer to "Notice" on page 4C-1.

- Prior to drive axle installation, cover the shock mounting bracket, lower control arm ball stud,

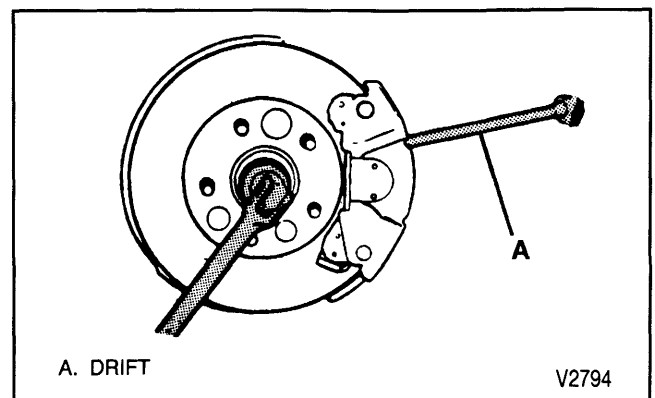


Figure 6—Holding Shaft in Place

4C-8 FRONT AXLE

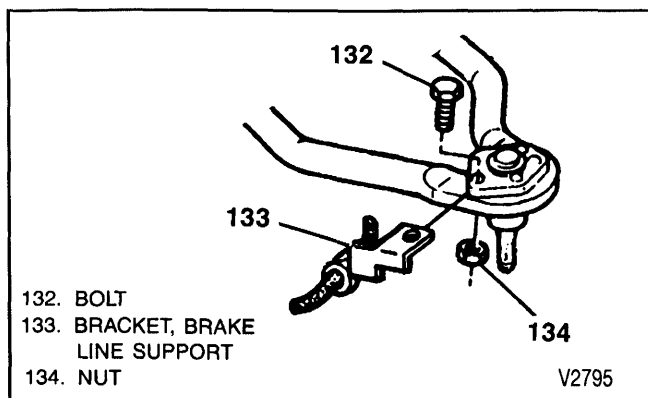


Figure 7—Brake Line Bracket Removal

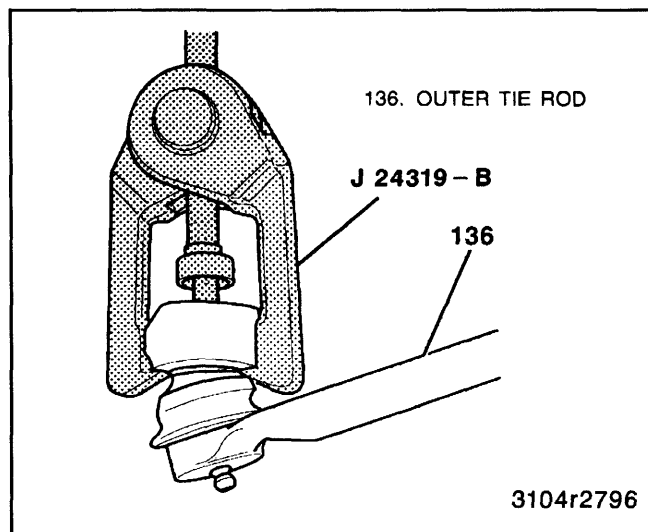


Figure 8—Disconnecting the Tie Rod

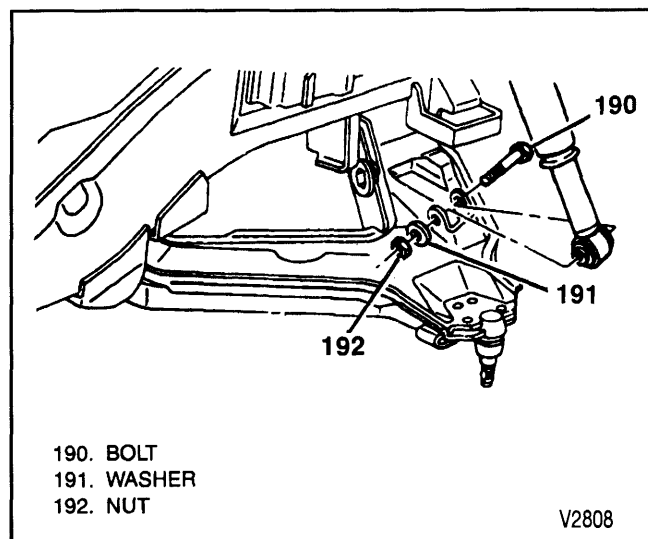


Figure 9—Disconnecting Lower Shock Mount

and all other sharp edges with shop towels so that drive axle seal is not damaged during assembly.

! Important

Lubricate the drive axle splines and knuckle with an approved high temperature wheel bearing grease.

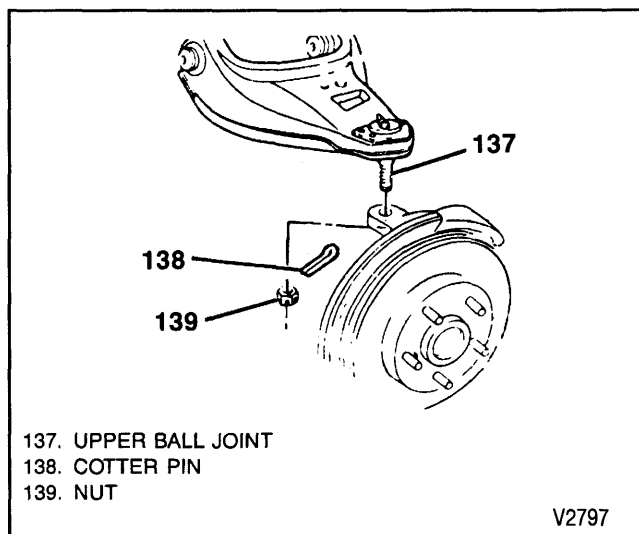


Figure 10—Ball Joint and Knuckle Separation

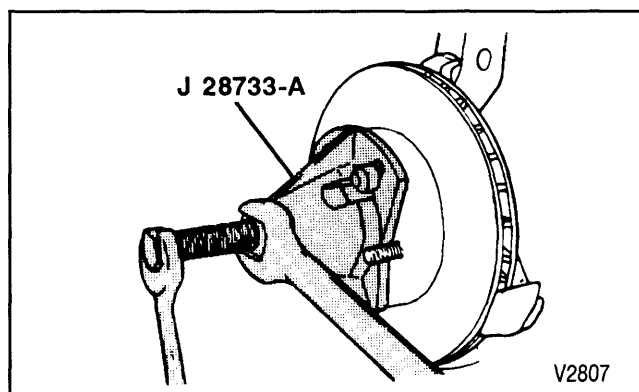


Figure 11—Splined Shank and Knuckle Separation

1. Insert outer C/V joint splined shank into knuckle hub and secure inboard C/V joint flange to companion flange with bolts. Do not tighten.
2. Upper ball joint to the steering knuckle.
3. Stud nut.



Tighten

- Stud nut to 83 N.m (61 lbs. ft.).
4. Cotter pin.
 - Lubricate the upper ball joint until grease appears at the seal.
 5. Stabilizer shaft bushing (65) and bracket (64) (figure 12).



Tighten

- Clamp to 33 N.m (24 lbs. ft.).
6. Stabilizer shaft bolt (62), spacer (56), and bushings (65).
 - Remove floor jack or stand from beneath lower control arm.
 7. Shock absorber to the lower shock mounting bracket.
 8. Shock mounting bolt (190), washer (191), and nut (192) (figure 9).



Tighten

- Nut to 73 N.m (54 lbs. ft.).

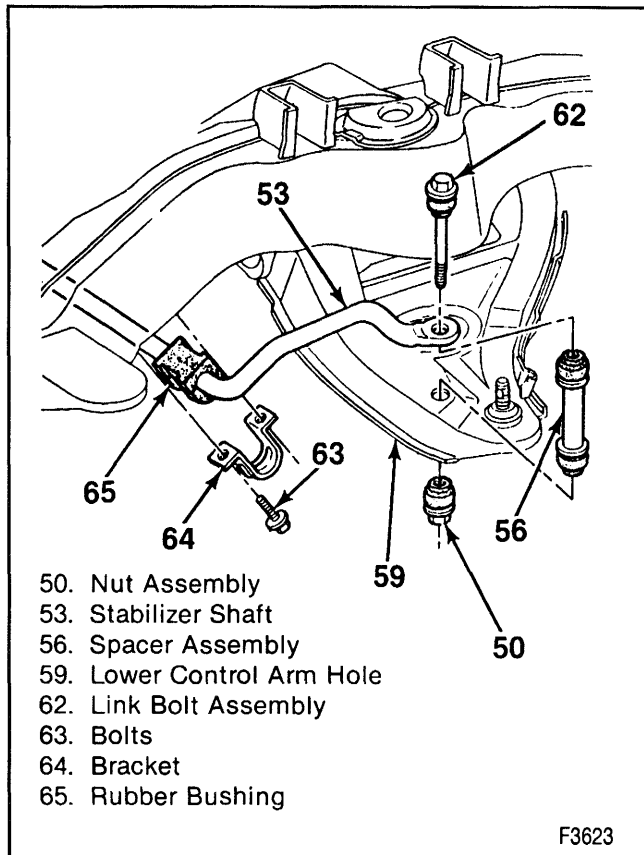


Figure 12—Stabilizer Bar Components

9. Outer tie rod to steering knuckle.
10. Outer tie rod nut.



Tighten

- Nut to 47 N.m (35 lbs. ft.).



Important

- Advance the nut to align the nut slot with the cotter pin hole. Never back the nut off to align the cotter pin hole.

11. Install new cotter pin and spread the ends to secure.
12. Brake pipe support bracket to the upper control arm.



Tighten

- Nut to 17 N.m (13 lbs. ft.).



Important

- Make sure that the brake hose is not twisted or kinked, or damage to the hose could result.

13. Hub nut washer (202) and nut (203). Seat shank splines in hub.
14. Insert a drift through brake caliper to prevent drive axle from turning.



Tighten

- Inboard flange bolts to 80 N.m (60 lbs. ft.).

15. Hub nut.



Tighten

- Hub nut to 245 N.m (180 lbs. ft.).
- Remove drift, install wheels, remove safety stands, and lower the vehicle.

OUTER CV JOINT/BOOT REPLACEMENT



Remove or Disconnect (Figures 13, 14, and 15)

Tools Required:

- J 8059 Snap Ring Pliers
- J 35910 Seal Clamp Tool
- J 36652 Swage Clamp Tool

1. Large swage ring (9) from the C/V joint, using a chisel and discard.



Important

- Do not cut through the seal (12) and damage the sealing surface of C/V outer housing (18) with the chisel.

2. Small seal-retaining clamp (11) on axle shaft with a side cutter, and discard.

- A. Separate the joint seal (12) from the C/V joint race (18) at large diameter and slide the seal away from joint along the axle shaft (13).

- B. Wipe excess grease from face of C/V inner race (16).

- C. Spread the ears on the race retaining ring (14) with J 8059 and remove the C/V joint assembly from the axle shaft (13).

3. Seal (12) from the axle shaft (13).

- Grease prior to installing the new seal.



Disassemble (Figures 13, 16 through 18)

1. Use a brass drift and hammer to gently tap on the C/V joint cage (17) until it is tilted enough to remove the first chrome alloy ball (15) (figure 16).
2. Tilt the cage (17) in opposite direction to remove opposing ball (15).

- Repeat this process until all six balls (15) are removed.

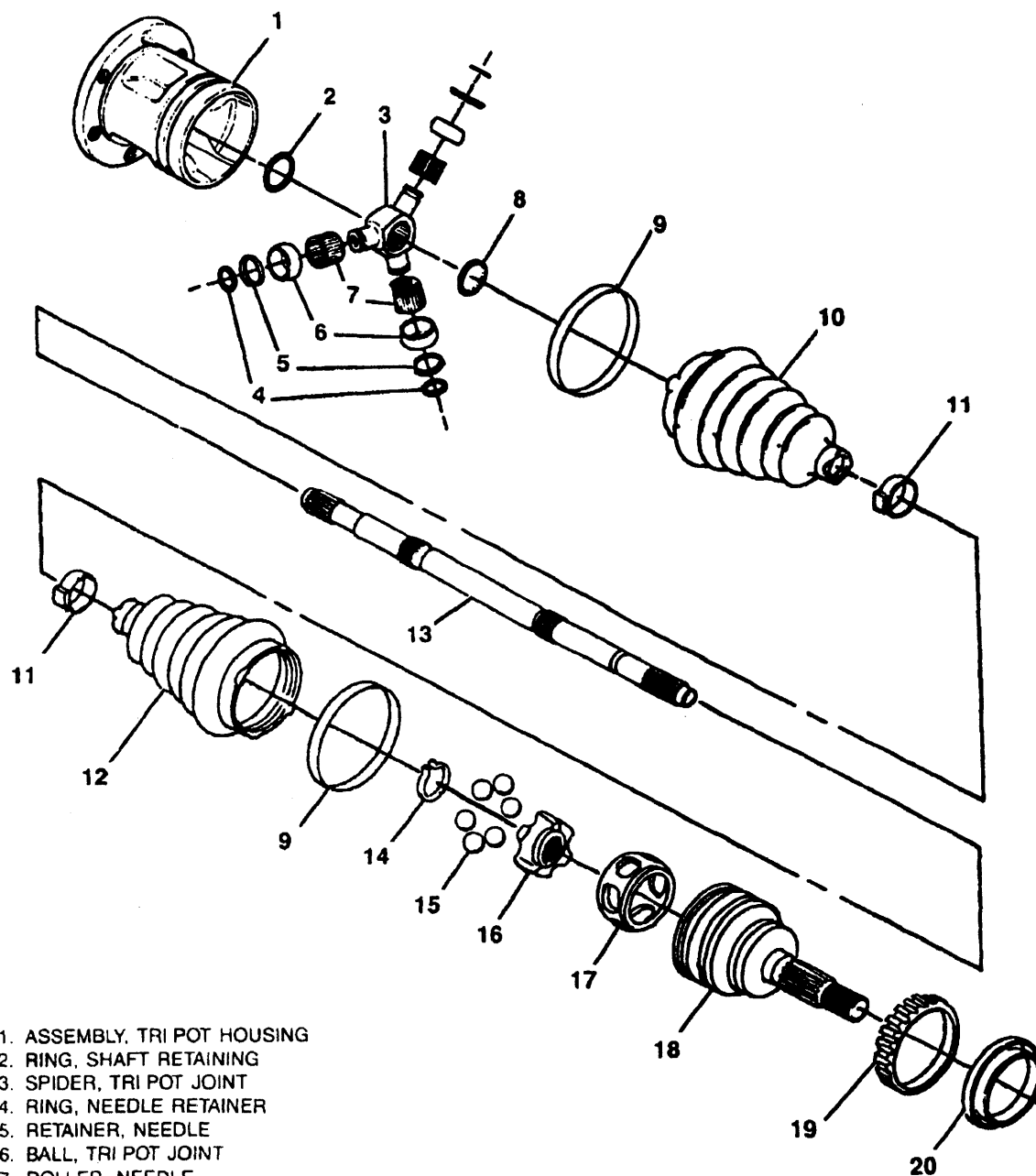
3. Position the cage (17) and the inner race (16) 90 degrees to the center line of the outer race (18) and align the cage windows with the lands of the outer race.

4. Separate the cage (17) and the inner race (16) from the outer race (18) (figure 17).

5. Rotate the inner race (16) 90 degrees to the center line of the cage (17) with the lands of the inner race aligned with the windows of the cage (figure 18).

6. Pivot the inner race (16) into the cage (17) window and remove the inner race.

4C-10 FRONT AXLE



1. ASSEMBLY, TRI POT HOUSING
2. RING, SHAFT RETAINING
3. SPIDER, TRI POT JOINT
4. RING, NEEDLE RETAINER
5. RETAINER, NEEDLE
6. BALL, TRI POT JOINT
7. ROLLER, NEEDLE
8. RING, SPACER
9. RING, SWAGE
10. SEAL, TRI POT JOINT
11. CLAMP, SEAL RETAINING
12. SHAFT, AXLE
13. SEAL, C/V JOINT
14. RING, RACE RETAINING
15. BALL
16. RACE, C/V JOINT INNER

17. CAGE, C/V JOINT
18. RACE, C/V JOINT OUTER
19. RING, SENSOR
20. RING, DEFLECTOR

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Figure 13—Front Drive Axle Components



Assemble (Figures 13 through 19)

Tools Required:

J 8059 Snap Ring Pliers (or equivalent)

J 35910 Boot Clamp Tool

J 36652 Swage Clamp Tool

- Put a light coat of recommended grease on the ball grooves of the inner race (16) and the outer race (18). Refer to SECTION 0B for specified grease.

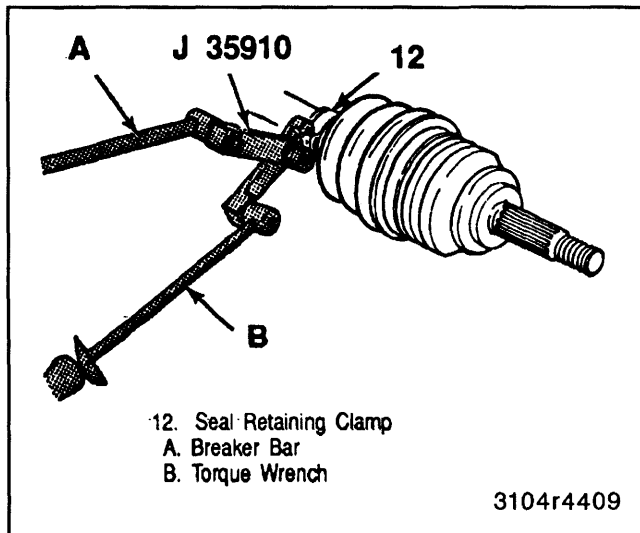


Figure 14—Installing Seal Retaining Clamp

- Inner race (16) into the cage (17) (figure 18).
 - Rotate into place. Cage with inner race to the outer race (figure 18).
 - Align the cage windows with the lands. Pivot the cage into position (figure 17).
 - Make sure the retaining side of the inner race faces out.
- Balls (15) (figure 16).
 - Tap on the cage with a brass drift to tilt it enough to install the balls.
- Small seal-retaining clamp (11) on the neck of the new seal (13). Do not crimp.
 - Slide the seal (12) onto the axle shaft (13) and position the neck of the seal in the seal groove on the axle shaft.
 - Crimp the self retaining clamp (11) using J 35910.



Tighten

- Retaining clamp (12) to 136 N.m (100 lbs. ft.) (figure 14).
 - Place approximately half of the grease provided inside the seal (12) and repack the C/V with the remaining grease.
- Swage ring (9).
 - Pinch by hand slightly to distort into an oval shape and slide onto large diameter of the seal (12).
 - Push C/V joint onto axle shaft (13) until retaining ring (14) is seated in groove on axle shaft (figure 19).

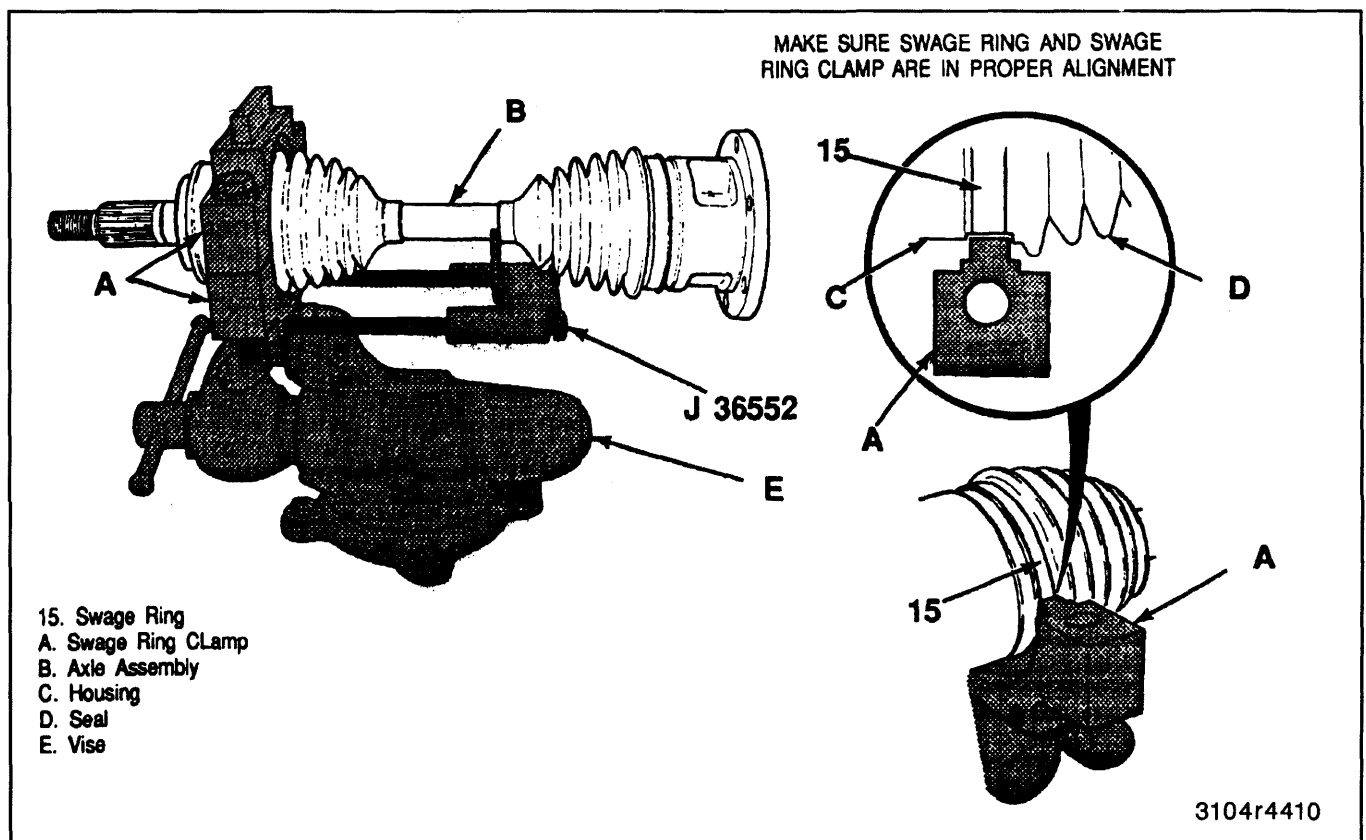


Figure 15—Installing Swage Ring

4C-12 FRONT AXLE

- C. Slide large diameter of the seal (12) with the large swage ring (9) in place over the outside of the C/V joint race (18) and locate the seal lip in the housing groove (figure 15).



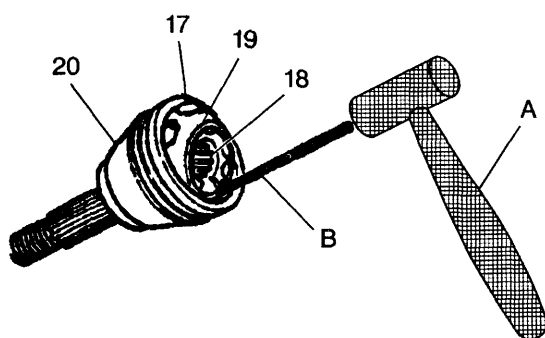
Important

- The seal (12) must not be dimpled, stretched or out of shape in any way. If the seal is not shaped correctly, carefully insert a thin flat blunt tool without no sharp edges between the large seal opening and the outer race (18) at maximum clearance of oval ring (9) to release the air. Shape the seal by hand and remove the tool.
- D. Refer to the chart in figure 15 and select the correct size swage clamp tool J 36652.
- E. Mount the proper size swage clamp tool in the vise and proceed as follows:
1. Position the outboard end of the axle assembly in the tool.
 2. Place the top half of the tool on the lower half of the tool and check for proper alignment.
 3. Insert the bolts and tighten by hand until snug.



Important

- Make sure the seal (12), housing (18), and swage ring (9) all remain in alignment (figure 15).



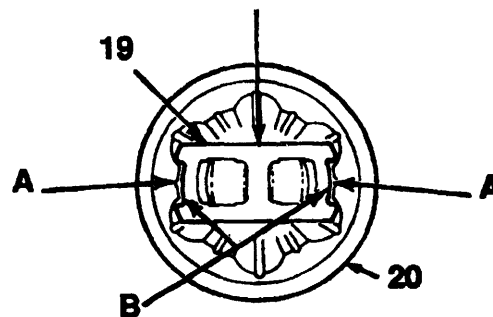
GENTLY TAP ON CAGE UNTIL TILTED ENOUGH TO REMOVE FIRST BALL. REMOVE OTHER BALLS IN A SIMILAR MANNER.

- A. HAMMER
B. BRASS DRIFT
17. BALL
18. C/V JOINT INNER RACE
19. C/V JOINT CAGE
20. C/V JOINT OUTER RACE

3104r4411

Figure 16—Removing C/V Joint Balls

PIVOT CAGE AND INNER RACE AT 90° TO CENTER LINE OF OUTER RACE WITH CAGE WINDOWS ALIGNED WITH LANDS OF OUTER RACE. LIFT OUT CAGE AND INNER RACE.

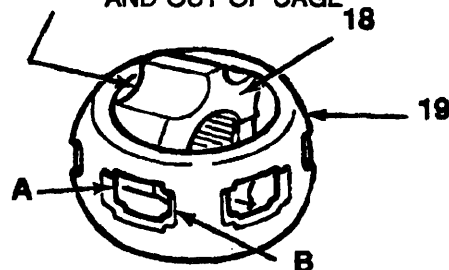


19. C/V Joint Cage
20. C/V Joint Outer Race
A. Land
B. Window

3104r4412

Figure 17—Separating Outer Race and Cage

ROTATE INNER RACE UP AND OUT OF CAGE



18. C/V Joint Inner Race
19. C/V Joint Cage
A. Inner Race Land
B. Cage Window

3104r4413

Figure 18—Separating Inner Race and Cage

4. Continue to tighten each bolt 180 degrees at a time alternately until both sides are bottomed.

F. Remove the axle assembly from the tool.



Install or Connect (Figures 13 and 14)

NOTICE: Refer to "Notice" on page 4C-1.

1. Small seal-retaining clamp (11) on the neck of the new seal (13). Do not crimp.

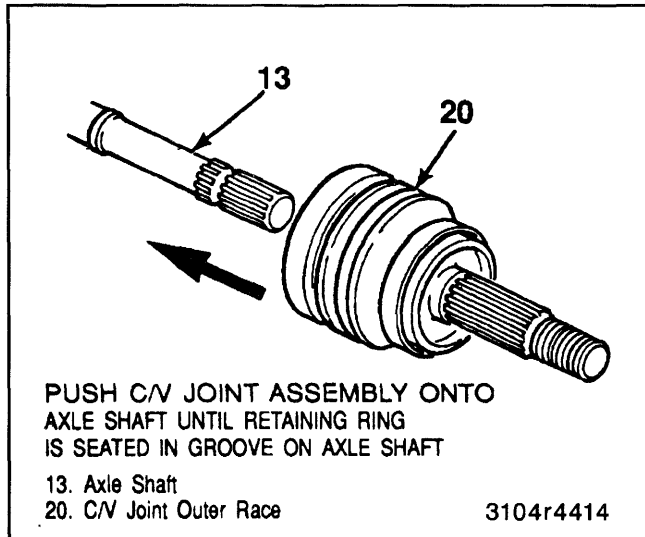


Figure 19—Installing C/V Joint to Axle

- A. Slide the seal (12) onto the axle shaft (13) and position the neck of the seal in the seal groove on the axle shaft.
 - B. Crimp the self-retaining clamp (11) with J 35910 to 136 N.m (100 lbs. ft.) (figure 19).
 - C. Place approximately half of the grease provided inside the seal (12) and repack the C/V with the remaining grease.
2. Swage ring (9).
 - A. Pinch by hand slightly to distort into an oval shape and slide onto large diameter of the seal (12).
 - B. Push C/V joint onto axle shaft (13) until retaining ring (14) is seated in groove on axle shaft.
 - C. Slide large diameter of the seal (12) with the large swage ring (9) in place over the outside of the C/V joint race (18) and locate the seal lip in the housing groove.

INNER CV JOINT/BOOT (TRIPOT HOUSING) REPLACEMENT

Disassemble (Figures 13 and 22)

Tools Required:

- J 8059 Snap Ring Pliers
- J 35910 Seal Clamp Tool
- J 36652 Swage Clamp Tool

1. Large swage ring (9) from the tripot joint, using a chisel, and discard.

Important

- Do not cut through the seal (10) with the chisel and damage the sealing surface of the tripot outer housing (1).
2. Small seal-retaining clamp (11) from the axle shaft (12) with a side cutter, and discard.
 - Separate seal (10) from the tripot housing (1) at the large diameter and slide the seal away from the joint along the axle shaft (13).

3. Tripot housing (1) from the spider (3) and shaft.
 - Spread the spacer ring (8) with J 8059 and slide the spacer ring and the tripot spider (3) back on the axle shaft (13).
4. Shaft retaining ring (2) from the groove on the axle shaft (13) and slide the spider assembly off the shaft (figure 21).

Important

- Handle the tripot spider assembly with care or the tripot balls and needle rollers may separate from the spider trunions.
5. Remove the spacer ring (8) and the seal (10) from the axle shaft (13).
 6. Flush grease from the housing.

Assemble (Figures 13, 14, 20 through 23)

1. Small seal-retaining clamp (11) on the neck of the seal (10).
 - Do not crimp.
2. Slide the seal (10) onto the shaft (13) and position the neck of the seal in the seal groove on the axle shaft.

Tighten

- Crimp seal retaining clamp (12) with J 35910 to 136 N.m (100 lbs. ft.) (figure 14).
3. Spacer ring (8) on the front axle shaft (13) and beyond the second groove as shown in figure 22.
 - Slide the tripot spider assembly against the spacer ring (8) and the shaft (13).

Important

- Be sure that the counterbored face of the tripot spider (3) faces the end of the shaft (13).
4. Shaft retaining ring (2) in the groove of the axle shaft (13) with J 8059.
 5. Slide the tripot spider (3) towards the end of the shaft (13) and reseal the spacer ring (8) in the groove on the axle (figure 22).
 - A. Place approximately half of the grease provided in the seal (10) and use the remainder to repack the tripot housing (1).
 6. Pinch the swage ring (9) by hand slightly to distort it into an oval shape and slide it onto the large diameter of the seal (12).
 7. Slide the tripot housing (1) over the tripot spider assembly on the shaft (13) (figure 20).
 8. Slide the large diameter of the seal (10) with the large swage ring (9) in place over the outside of the tripot housing (1) and locate the seal lip in the housing groove.
 9. Position the tripot assembly at the proper vehicle dimension as shown in figure 23.

Important

- The seal (12) must not be dimpled, stretched or out of shape in any way. If the seal is not shaped correctly, slide the swage ring (9) off the

4C-14 FRONT AXLE

seal and onto the housing (1). Carefully insert a thin, flat, blunt tool between the seal opening and the housing to release the air. Shape the seal properly by hand and remove the tool. (figure 13).

10. Return the swage ring (9) to position on seal (12).
 - Refer to the chart in figure 15 and select the proper size swage clamp tool J 36652.
11. Mount the swage clamp tool in the vise and proceed as follows:
 - A. Position the inboard end of the axle assembly in the tool.
 - B. Place the top half of the proper size tool on the lower half of tool and check for proper alignment and dimension (figures 15 and 23).
 - C. Insert the bolts and tighten by hand until snug.

Important

- Make sure that the seal, housing, and swage ring (15) all remain in alignment (figure 15).
- D. Continue to tighten each bolt 180 degrees at a time, alternating until both sides are bottomed.
12. Remove the axle assembly from the tool.

SHAFT AND AXLE TUBE ASSEMBLY REPLACEMENT

Remove or Disconnect (Figures 3, 5, 12, and 24)

- Raise the vehicle and support it using safety stands.
 - Position a pan under the axle to catch oil.
1. Bolts (63) from the left and right stabilizer brackets (64) (figure 12).
 2. Right stabilizer link nut assembly (50), spacer (56), and link bolt assembly (62) (figure 12).
 3. Inner tie rod end from relay rod. Refer to SECTION 3B3.

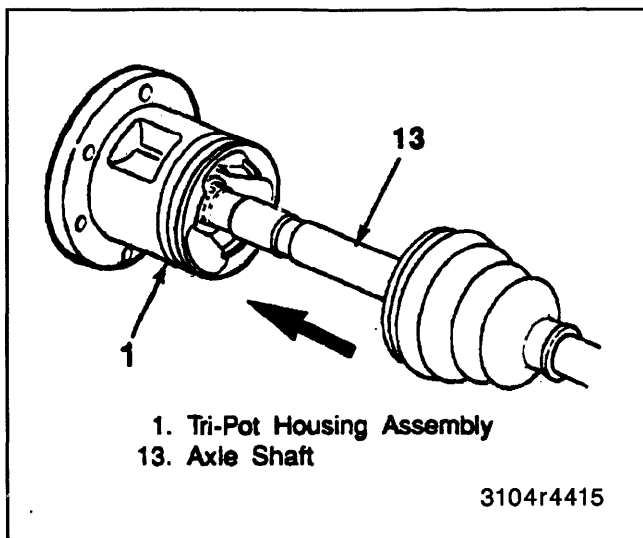


Figure 20—Installing Tripot to Housing

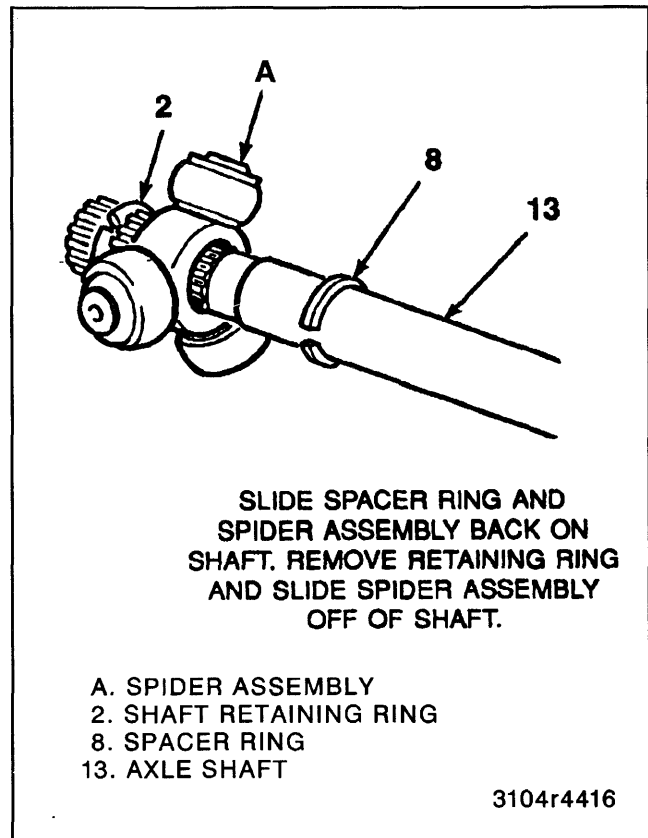


Figure 21—Removing Spider Assembly

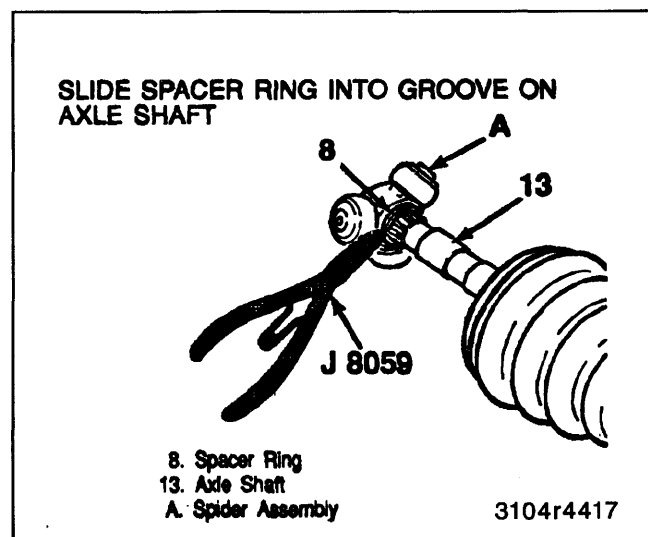


Figure 22—Installing Spider Assembly

4. Axle flange bolts (200) (figure 5).
 - Turn wheel out to loosen the drive axle from the axle tube.
 - Push drive axle toward the front of the truck and tie it out of the way.
5. Actuator connector (12) (figure 3).
6. Indicator light connector (11) (figure 3).
7. Skid plate, if necessary. Refer to "Skid Plate Replacement."
8. Drain plug (27) and washer (28) from the carrier and drain the axle lubricant into a suitable container.

9. Axle mounting nuts (130) and washers (126) (figure 24).
10. Axle tube to carrier bolts (6).
11. Axle tube from carrier.

- Take care to keep the open end of the tube up.



Disassemble (Figure 3)

Tools Required:

- J 29369-1 Bearing Remover (K2 models)
- J 29369-2 Bearing Remover (K3 models)

- Hold the axle tube in a vise by the mounting flange.

1. Sleeve (10).
2. Gear (8).
3. Thrust washer (7).
4. Axle shaft (1). Tap out with a soft mallet.
5. Deflector (2). Pry out with a screwdriver.
6. Seal (3). Pry out with a screwdriver.
7. Bearing (4). Use J 29369-1 (K2 models) or J 29369-2 (K3 models) and a slide hammer.



Clean

- Parts in a suitable solvent.
- Gasket surfaces on the axle tube and carrier housing.

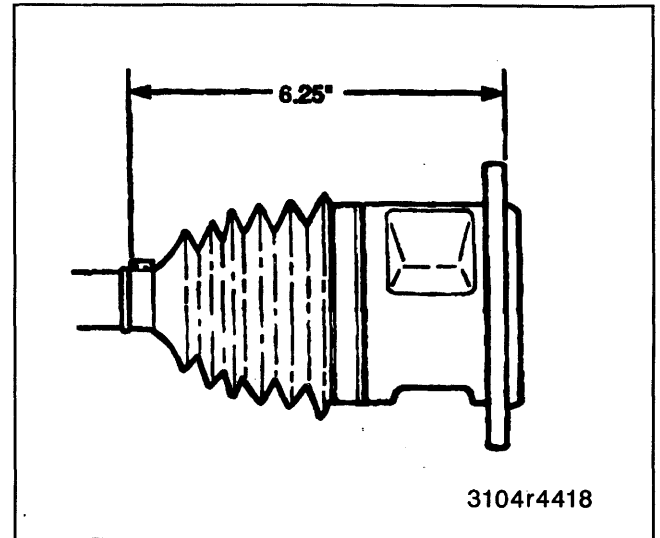


Figure 23—Tripot Seal Installation Measurements



Assemble (Figures 3 and 24)

Tools Required:

- J 36609 Bearing Installer
- J 36600 Seal Installer (K2 Models)
- J 22833 Seal Installer (K3 Models)

1. New bearing (4). Use J 36609. Apply axle lubricant to the bearing.
2. New seal (3). Use J 36600 (K2 models) or J 22833 (K3 models). Coat the seal lips with grease.
3. Deflector (2).

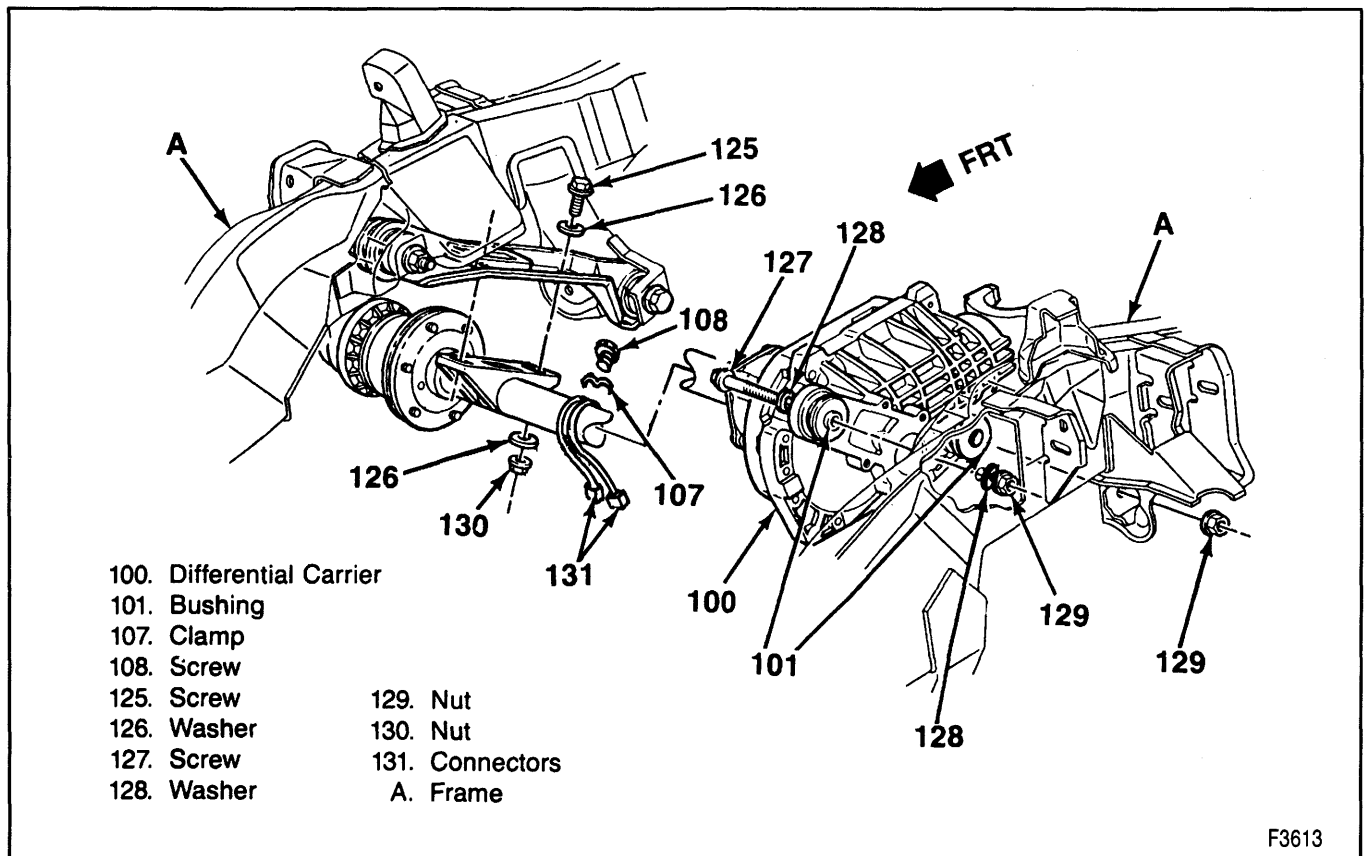


Figure 24—Differential Carrier Mounting

4C-16 FRONT AXLE

4. Axle shaft (1).
5. Thrust washer (7). Use grease to hold it in place. Make sure the tabs on the washer align with the slot in the axle tube.
6. Gear (8).
7. Sleeve (10).

Install or Connect (Figures 3, 5, 12, and 24)

NOTICE: For steps 2, 4, 5, 7, 8, 11, and 13, refer to "Notice" on page 4C-1.

- Apply sealant (GM P/N 12345739) or equivalent to the carrier sealing surface.

1. Axle tube (5) to carrier (24).
2. Bolts (6).

Tighten

- Bolts to 40 N.m (30 lbs. ft.).

3. Drive shaft to axle shaft.
4. Bolts (200) (figure 5).

Tighten

- Bolts to 80 N.m (59 lbs. ft.).

5. Axle mounting nuts (130) with washers (126) (figure 24).

Tighten

- Nuts (130) to specifications:
 - K2 models: 100 N.m (75 lbs. ft.).
 - K3 models: 145 N.m (106 lbs. ft.).

6. Tie rod end to relay rod. Refer to SECTION 3B3.
7. Stabilizer link (62) (figure 12).

Tighten

- Nut to 18 N.m (13 lbs. ft.) until the nuts meet the end of the bolt threads for torque value.

8. Stabilizer bracket to frame nuts (63) (figure 12).

Tighten

- Bolts to 33 N.m (24 lbs. ft.).

9. Actuator connector (12).
10. Indicator connector (11).
11. Drain plug (27) and the washer (26).

Tighten

- Plug to 33 N.m (24 lbs. ft.).

12. New lubricant. Refer to "Specifications."
13. Fill plug (26).

Tighten

- Plug to 33 N.m (24 lbs. ft.).

14. Skid plate, if necessary. Refer to "Skid Plate Replacement."

SHIFT FORK REPLACEMENT

Remove or Disconnect (Figure 3)

1. Shaft and axle tube assembly as outlined earlier in this section.
2. Shift shaft (18), damper spring (17), fork (16), and clip (15) assembly.
3. Spring (14) from the carrier case, taking care not to dislodge the shim (20) from the output shaft.

Install or Connect (Figure 3)

1. Spring (14) into the carrier case.
2. Shift shaft (18), damper spring (17), fork (16), and clip (15) assembly into axle tube.
 - Make sure the clip is fully seated into the groove on the shift lever.
3. Shaft and axle tube assembly.

DIFFERENTIAL PILOT BEARING REPLACEMENT

Remove or Disconnect (Figure 3)

Tool Required:

J 34011 Pilot Bearing Remover

J 33842 Pilot Bearing Installer

1. Shaft and axle tube assembly. Refer to "Shaft and Axle Tube Assembly Replacement."
2. Shim (20).
3. Differential pilot bearing (21). Use J 34011.

Install or Connect (Figure 3)

1. Shim (20).
2. Differential pilot bearing (21). Use J 33842.
 - Lubricate the bearing with axle lubricant.
3. Shaft and tube assembly. Refer to "Shaft and Axle Tube Assembly Replacement."

OUTPUT SHAFT REPLACEMENT

Remove or Disconnect (Figure 3)

- Raise the vehicle. Support with jack stands.
 - Place a drain pan under the axle to catch oil.
1. Left drive axle. Refer to "Drive Axle Replacement."
 2. Lower carrier mounting bolt.
 - Carefully pry against the lower carrier to provide clearance for output shaft removal. Take care not to damage the carrier case.
 3. Output shaft (32). Attach a slide hammer with adapter to the output shaft and pull it from the carrier case. Take care not to damage the case.
 4. Deflector (31).
 5. Seal (29). Pry out with a screwdriver.

Install or Connect (Figure 3)

Tools Required:

J 36600 Seal Installer (K2 models)

J 22833 Seal Installer (K3 models)

1. New seal (29). Use J 36600 (K2 models) or J 22833 (K3 models). Lubricate the seal lips with grease.
2. Deflector (31).
3. Output shaft (32). Carefully pry against the lower carrier to provide clearance. Take care not to damage the carrier case. Tap the output shaft into place with a soft mallet.

NOTICE: Refer to "Notice" on page 4C-1.

4. Lower carrier mounting bolt, washers, and nut.



Tighten

- Bolts to 110 N.m (80 lbs. ft.).
5. Left drive axle. Refer to "Drive Axle Replacement."
 - Add lubricant as required to the axle. Refer to "Specifications" at the end of this section.

PINION FLANGE, DUST DEFLECTOR, AND OIL SEAL REPLACEMENT



Remove or Disconnect (Figures 25, 26, 27 and 28)

Tool Required:

J 8614-01 Companion Flange Holder and Remover

- Raise the vehicle on a hoist.

1. Propeller shaft from the axle. Refer to SECTION 4A.
 - Tie the propeller shaft to a frame rail or cross-member.



Measure

- The torque required to rotate the pinion. Record the torque value for reassembly (figure 25).



Important

- Scribe a line on the pinion stem, pinion nut and the companion flange and record the number of exposed threads on the pinion stem (figure 26).

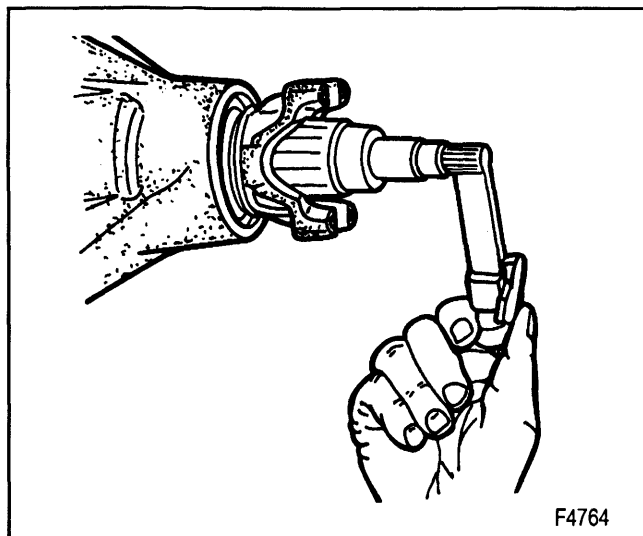


Figure 25—Measuring the Pinion Rotating Torque

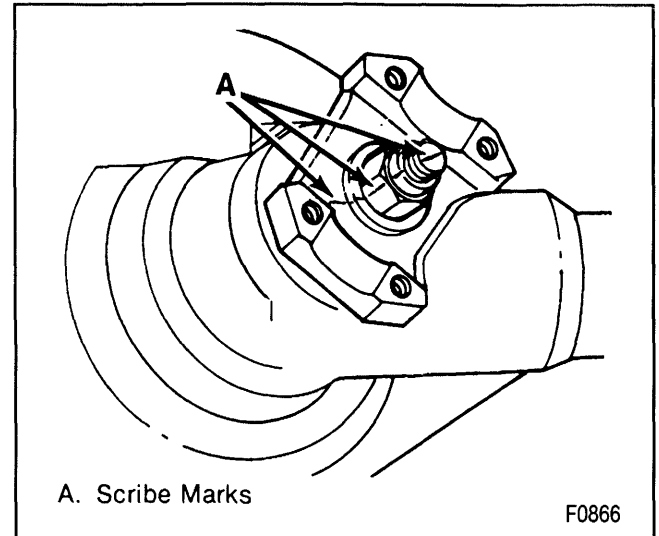


Figure 26—Scribed Marks

2. Nut using J 8614-01 (figure 27).
 - Position J 8614-01 on the flange so that the four notches on the tool face the flange.
3. Flange using J 8614-01 (figure 28).
 - Use the special nut and forcing screw to remove the flange.
4. Oil seal.
 - Carefully pry the seal from the bore. Do not distort or scratch the aluminum case.



Inspect

- The pinion flange for a smooth oil seal surface.

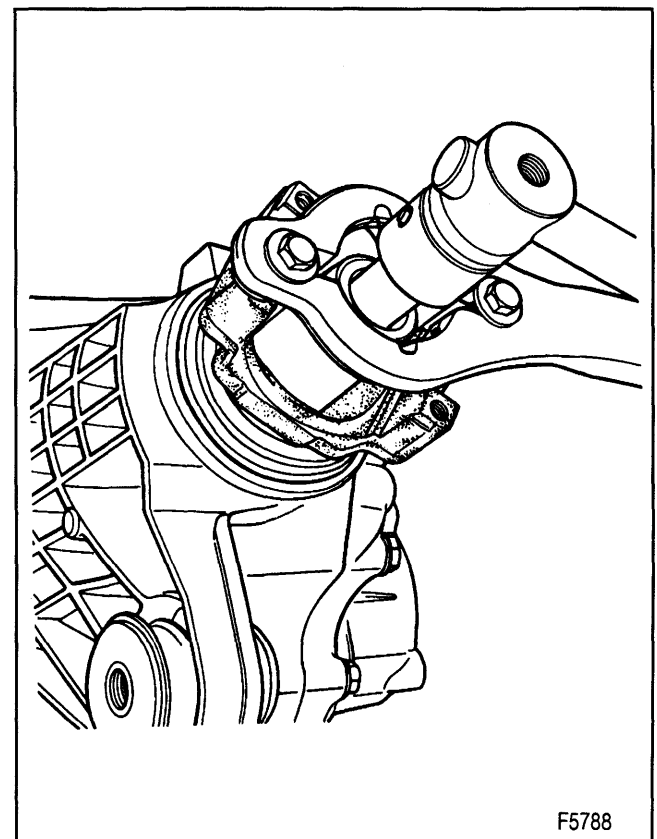


Figure 27—Removing/Installing the Pinion Nut

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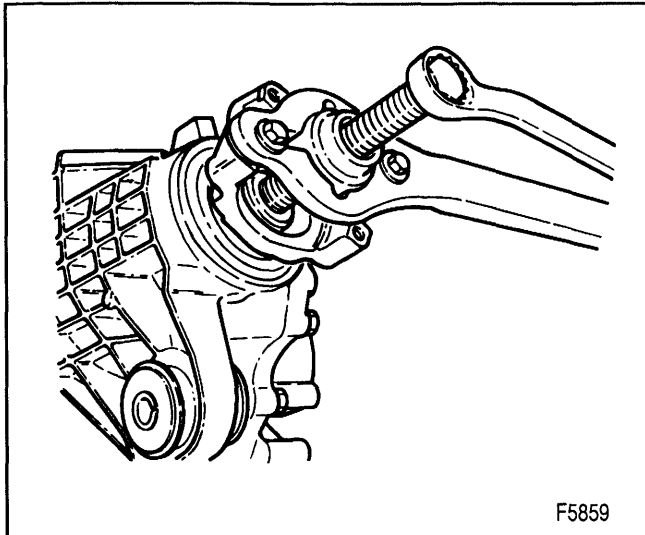


Figure 28—Removing/Installing the Pinion Flange

- The pinion flange for worn drive splines.
 - Replace if necessary.
5. Dust deflector.
- Tap the deflector from the flange.
 - Clean up the stake points on the flange.

Install or Connect (Figures 28 and 29)

Tools Required:

J 8614-01 Companion Flange Holder and Remover

J 36366 Seal Installer

1. Dust deflector on the flange.
 - Stake the new deflector at three new equally spaced positions. Staking must be such that the seal operating surface is not damaged.
2. Oil seal using J 36366 (figure 29).
 - Position the oil seal in the bore, then place J 36366 over the oil seal. Strike J 36366 with a hammer until the seal flange is seated on the axle housing surface. Drive the seal in straight, not at an angle, as this will damage the aluminum housing.

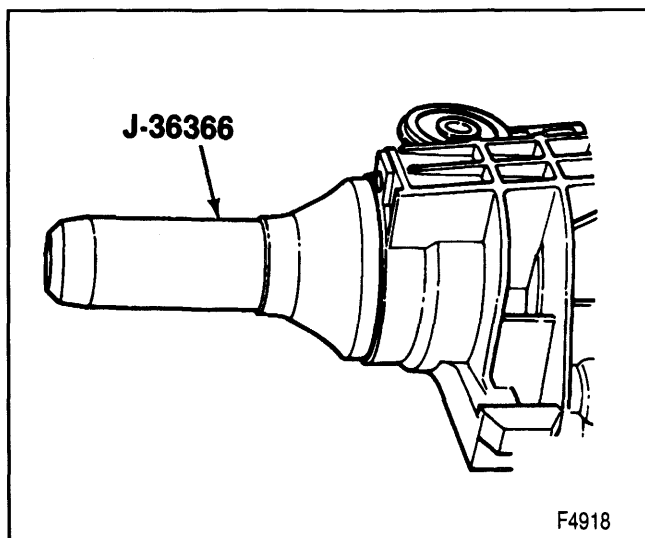


Figure 29—Installing the Pinion Seal

NOTICE: Do not hammer the pinion flange onto the pinion shaft or the pinion flange may be damaged.

3. Flange onto the pinion using J 8614-01 (figure 28).
 - Place the washer and a new nut on the pinion threads and tighten the nut to the original scribed position using the scribe marks and exposed threads as a reference.



Measure

- The rotating torque of the pinion and compare this with the rotating torque recorded earlier.



Tighten

- The pinion nut by small increments until the torque required to rotate the pinion is 0.35 N·m (3 lbs. in.) greater than the original torque.
4. Propeller shaft. Refer to SECTION 4A.
 5. Lower the vehicle.

CARRIER REPLACEMENT



Remove or Disconnect (Figure 24)

- Raise the vehicle. Support with jack stands.
1. Skid plate (if equipped).
 - Drain the axle lubricant, if necessary.
 2. Front propeller shaft at the carrier yoke. Refer to SECTION 4A. Wire the propeller shaft out of the way.
 3. Drive axle bolts at the carrier output shafts. Move the axle shafts out of the way and secure in position.
 4. Wiring at the axle.
 5. Vent hose at the axle.
 6. Screws (125), nuts (130) and washers (126).
 7. Carrier lower mounting bolt.
 8. Right side inner tie rod end from the relay rod. Refer to SECTION 3B3.
 9. Engine oil filter (some models).
 10. Attach a transmission jack to the carrier.
 11. Upper carrier mounting bolt.
 12. Carrier from the vehicle.
 - Refer to the Light Duty Truck Unit Repair Manual for repair information.



Install or Connect (Figures 5 and 24)

NOTICE: For steps 2, 6, 9, and 10, refer to "Notice" on page 4C-1.

1. Carrier to the vehicle.
2. Carrier mounting bolts (127), nuts (129), and washers (128).



Tighten

- Bolts (127) to 110 N·m (80 lbs. ft.).
3. Remove the transmission jack.
 4. Engine oil filter (if removed).

5. Tie rod. Refer to SECTION 3B3.
6. Axle tube bolts (125), nuts (130), and washers (126).



Tighten

- Nuts (130) to specifications.
 - K2 models: 100 N.m (75 lbs. ft.).
 - K3 models: 145 N.m (110 lbs. ft.).

7. Vent hose.
8. Wiring.
9. Drive axle (201) to output shaft bolts (200) (figure 5).



Tighten

- Bolts to 80 N.m (60 lbs. ft.).

10. Front propeller shaft to the carrier yoke.



Tighten

- Universal joint clamp bolts to 20 N.m (15 lbs. ft.).
- Fill the carrier with lubricant, if necessary. Refer to "Specifications" in this section.

11. Skid plate (if equipped).
12. Add engine oil, if the oil filter was removed.

CARRIER CASE BUSHING REPLACEMENT



Remove or Disconnect (Figures 3, 24, and 30)

Tool Required:

J 36616 Bushing Remover and Installer

1. Carrier, as outlined previously. Refer to "Carrier Replacement."
2. Carrier bushing using J 36616 (figure 30).



Install or Connect (Figures 3, 24, and 30)

Tool Required:

J 36616 Bushing Remover and Installer

1. Carrier bushing using J 36616 (figure 30).
2. Carrier, as outlined previously. Refer to "Carrier Replacement."

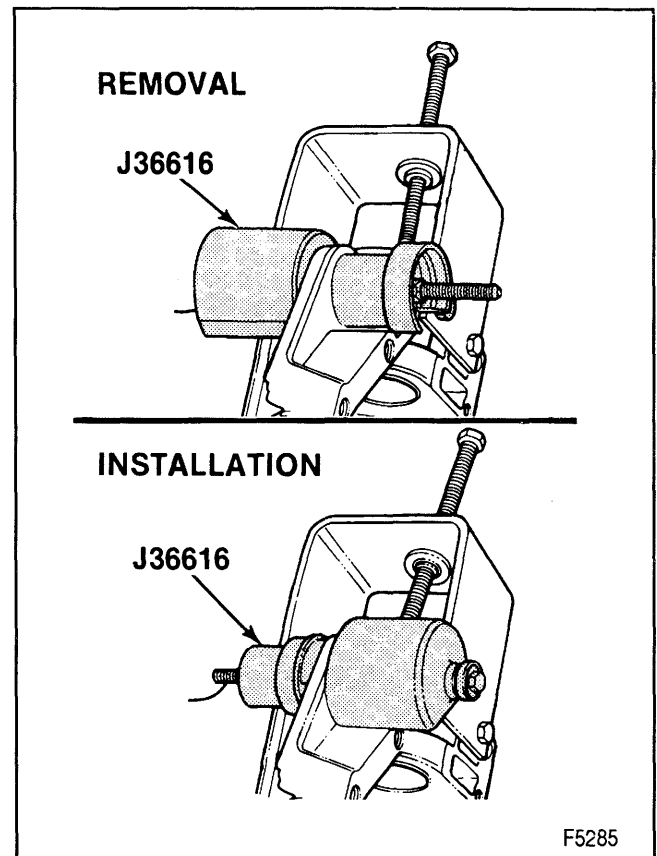


Figure 30—Removing/Installing Carrier Case Bushings

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Lbs. Ft.
Carrier Frame Screws.....	22	16
Drive Axle Nut at Front Hub.....	245	180
Drive Axle Screws.....	145	110
Engagement Switch	20	15
Plug, Drain and Fill	33	80
Right Side Axle Tube to Frame Nuts		
K2 Models	40	30
K3 Models	100	75
Thermal Actuator.....	22	16

LUBRICATION

Capacity

Fill to the level of the filler plug hole.

K2 Models	1.66L	1.75 Qt.
K3 Models	2.13L	2.25 Qt.
Type Recommended	SAE 80W-90 GL5 Gear Lubricant (SAE 80W GL5 in Canada)	

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SPECIAL TOOLS

1.  J 29369-1
2.  J 29369-2

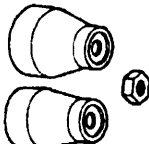
3.  J 34011

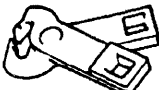
4.  J 22833
5.  J 36600

6.  J 36609

7.  J 33842

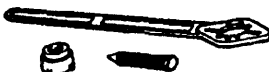
8.  J 36616

9.  J 36845

10.  J 35910

11.  J 36605

12.  J 24319-B

13.  J 8614-01

14.  J 28733-B

15.  J 8059

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1. AXLE TUBE BEARING REMOVER (K2 MODELS)
2. AXLE TUBE BEARING REMOVER (K3 MODELS)
3. DIFFERENTIAL PILOT BEARING REMOVER
4. AXLE TUBE SEAL INSTALLER (K3 MODELS)
5. AXLE TUBE SEAL INSTALLER (K2 MODELS)
6. AXLE TUBE BEARING INSTALLER
7. DIFFERENTIAL PILOT BEARING INSTALLER
8. CARRIER CASE BEARING INSTALLER
9. DRIVE AXLE BOOT CLAMP PROTECTOR INSTALLER
10. SEAL CLAMP TOOL
11. KNUCKLE SEAL INSTALLER
12. STEERING LINKAGE PULLER
13. PINION FLANGE HOLDER
14. FRONT HUB SPINDLE REMOVER
15. SNAP RING PLIERS

BRAKES

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SECTION 5

HYDRAULIC BRAKES

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, by cleaning brake parts with a dry brush or with compressed air. Many earlier model or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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5-2 HYDRAULIC BRAKES

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GENERAL DESCRIPTION

FLUID AND FLUID HANDLING

CAUTION: Brake fluid may be irritating to skin or eyes. In case of contact, take the following actions:

- Eye contact - rinse eyes thoroughly with water.
- Skin contact - wash skin with soap and water.

NOTICE: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

Use Delco Supreme 11 Brake Fluid (GM P/N 1052535) or an equivalent DOT-3 motor vehicle brake fluid.

Brake fluid should always be stored in a closed container. Re-seal brake fluid containers immediately after use. Brake fluid left in an open or improperly sealed container will absorb moisture. This can lower the fluid's boiling point and result in system contamination, corrosion, or deterioration of rubber components.

SUBSTANDARD OR CONTAMINATED BRAKE FLUID

NOTICE: Power steering fluid and brake fluid cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.

No special fluids are used in this system. However, care must be taken to use the correct fluids. The master cylinder and brake system uses brake fluid, while the hydraulic booster system uses power steering fluid.

Improper fluid, water, or any other contaminants in the fluid may cause the brake fluid to boil or rubber components to deteriorate in the hydraulic system.

Swollen master cylinder piston seals show that rubber deterioration has occurred. This deterioration is also shown by swelling of wheel cylinder boots, caliper boots, or master cylinder reservoir diaphragm.

If rubber deterioration is found, replace all rubber parts in the system, including the hoses. Check for fluid on the brake linings. If any is found, replace the linings.

If the brake fluid is contaminated and the master cylinder piston seals are satisfactory, check for leaks or excessive heat conditions. If no leaks or excessive heat conditions are found, flush the system.

FLUSHING THE SYSTEM

Flushing the brake hydraulic system involves running new brake fluid through the system until the fluid at each bleeder valve comes out clear. This is the only way to clean contaminated fluid out of the system.

The brake hydraulic system should be flushed with clean brake fluid any time new hydraulic parts are installed. Flushing is also recommended if there is any question of contamination, the grade of fluid in the system, or mineral oil in the fluid.

HEIGHT-SENSING BRAKE PROPORTIONING VALVE

The height-sensing brake proportioning valve regulates fluid pressure to the rear brakes according to the load in the rear of the vehicle (figure 1). It is located just in front of the rear axle. Linkage connects the valve lever to the frame of the vehicle. The lever moves as the load in the rear of the vehicle changes. The valve allows less fluid with a light load and more fluid with a heavy load. This helps provide the right amount of rear brake performance based on the load the vehicle is carrying.

COMBINATION VALVE

The combination valve has three sections (figure 2). Each section serves a different function.

The metering or hold off section (A) limits pressure to the front brakes until a predetermined input pressure is reached. This should be enough pressure to overcome

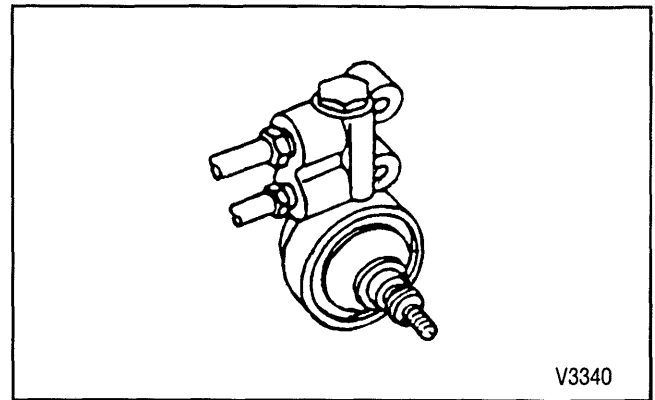


Figure 1—Height-Sensing Brake Proportioning Valve

the rear brake shoe springs. There is no restriction to inlet pressures below 200 kPa (30 psi). This allows for pressure equalization during no apply periods.

The pressure differential warning switch (B) constantly compares front and rear brake pressures from the master cylinder. If the front or rear brake systems malfunction, it energizes the warning lamp on the dash. The switch latches in the “warning” position after a malfunction occurs. The only way to turn the lamp off is to repair the malfunction and apply enough pedal force to develop about 3100 kPa (450 psi) line pressure.

The proportioning section (C) limits pressure to the rear brakes after a predetermined rear input pressure has been reached. This prevents rear wheel lock-up on vehicles with light rear wheel loads.

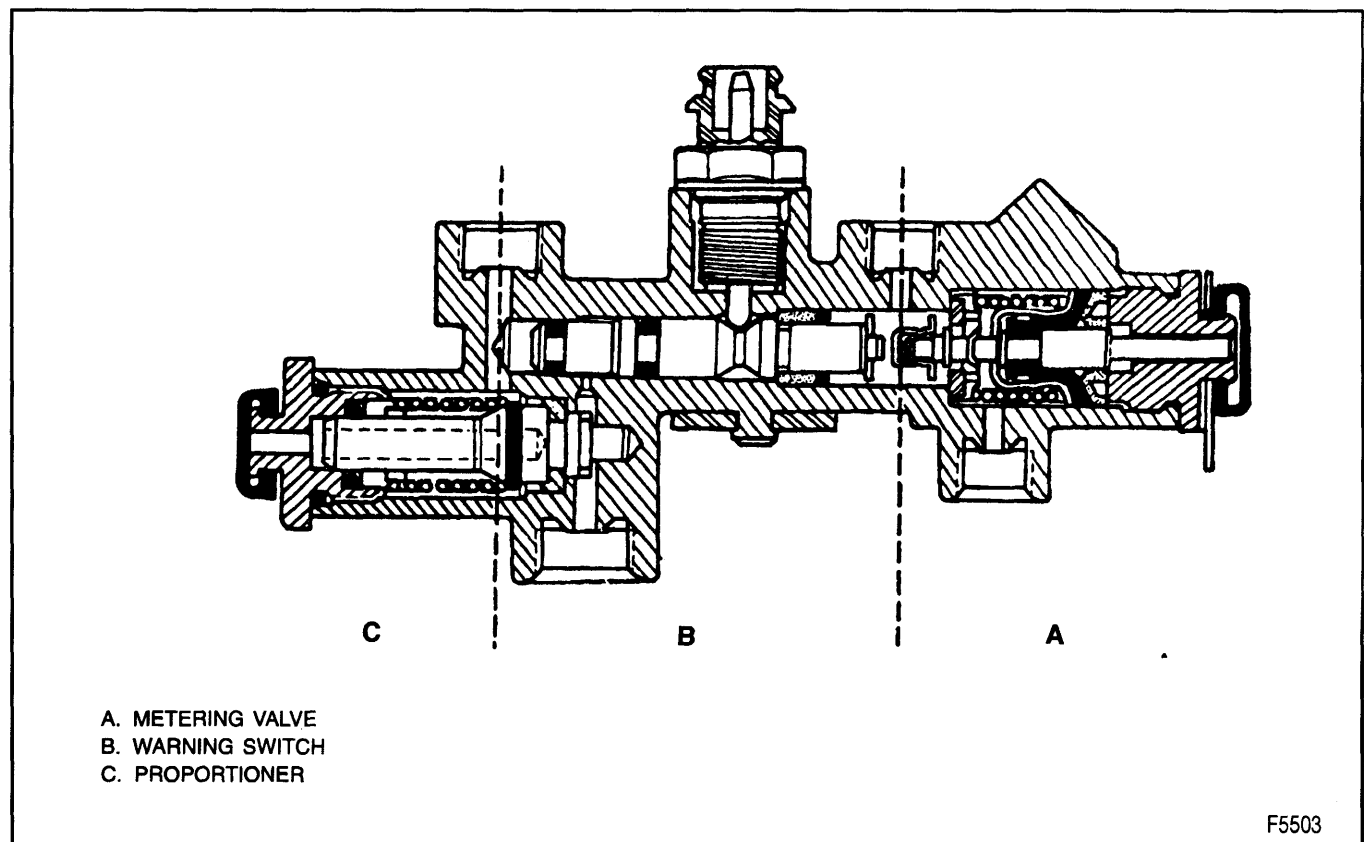


Figure 2—Combination Valve

5-4 HYDRAULIC BRAKES

The combination valve includes a "by-pass" feature. This ensures full system pressure to the rear brakes in the event of a front brake malfunction or full system pressure to the front brakes in the event of a rear brake malfunction.

STOPLAMP SWITCH

The zero adjust stoplamp switch design eliminates the need for stoplamp switch adjustment because the switch is installed along with the brake push rod and held by a single retainer.

WARNING/INDICATOR LAMP OPERATION

"BRAKE" LAMP

The "BRAKE" warning lamp in the instrument cluster warns the driver of either a loss of hydraulic fluid pressure, parking brake operation, or a possible malfunction

in the antilock brake system. The "BRAKE" lamp will illuminate when ground is supplied from either the combination valve switch, parking brake switch, brake pressure modulator valve (4WAL), or electric brake control module (RWAL).

"ANTILOCK" LAMP

The "ANTILOCK" indicator lamp in the instrument cluster is only used on models with four wheel antilock brakes. This lamp informs the driver of antilock system operation and malfunctions. When a malfunction occurs, the brake pressure modulator valve completes the circuit to the lamp. The lamp may remain illuminated or turn back off depending on the nature of the malfunction. For additional information, refer to SECTION 5E1. The "BRAKE" lamp serves as a backup if a malfunction occurs in this circuit.

DIAGNOSIS

BRAKE SYSTEM TESTING



Important

- If the vehicle pulls to one side during braking, make sure the front end alignment is correct before assuming the condition relates to a brake system malfunction.

Brakes should be tested on a dry, clean, reasonably smooth, and level roadway. A true test of brake performance cannot be made if the roadway is wet, greasy, or covered with loose dirt. These conditions prevent the tires from gripping the road equally. A crowned roadway also affects brake testing by throwing the weight of the vehicle toward the wheels on one side. Roadway rough enough to cause the wheels to bounce also affects this test.

Test the brakes at different vehicle speeds with light and heavy pressure. Avoid locking the wheels and sliding the tires on the roadway. Locked wheels and sliding tires do not indicate brake efficiency. Heavily braked turning wheels will stop the vehicle in less distance than locked wheels. More tire-to-road friction is present with a heavily braked turning tire than a sliding tire.

EXTERNAL CONDITIONS THAT AFFECT BRAKE PERFORMANCE

1. **Tires**--Tires with unequal contact and grip on the road will cause unequal braking. The inflation and tread pattern of the right and left tires must be about equal.
2. **Vehicle Loading**--When the vehicle has unequal loading, the most heavily loaded wheels require more braking force than the others.
3. **Front Wheel Bearings**--Loose front wheel bearings permit the rotor to tilt and have spotty contact with the linings. This causes erratic braking.
4. **Front End Alignment**--Misalignment of the front end, particularly camber and caster, causes the brakes to pull to one side.

BRAKE PEDAL TRAVEL

Tool Required:

Brake Pedal Effort Gage, such as J 28662

At frequent intervals, brake pedal travel should be checked (figure 3). Travel is the distance the pedal moves toward the floor from a full released position. This check should be made with the brakes cold and

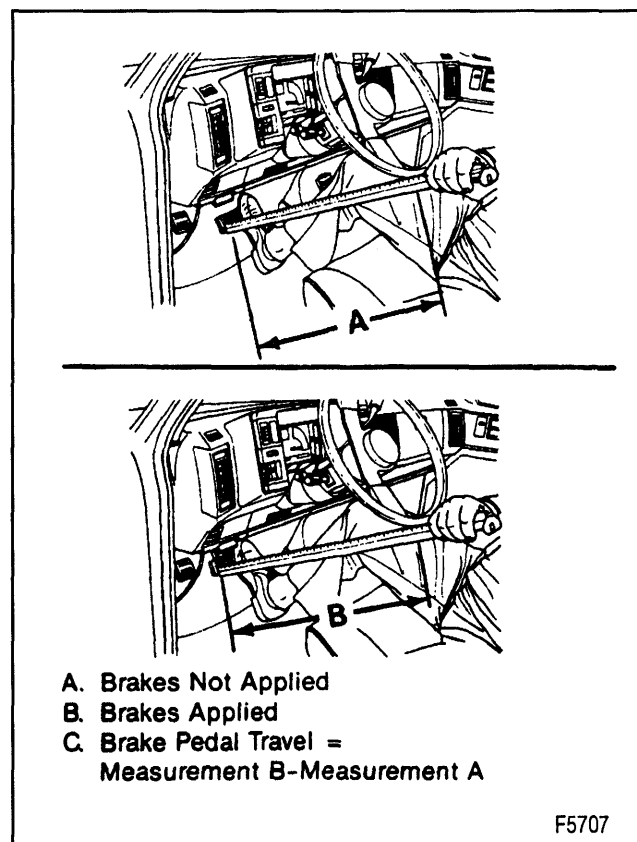


Figure 3—Checking Brake Pedal Travel

about 445 N (100 lbs.) of force on the pedal using a brake pedal effort gage, such as J 28662.

1. Apply the brake pedal at least five times with the engine off to remove vacuum from the booster before making the check.
2. Measure the distance from the bottom of the steering wheel to the brake pedal.
 - A. Take the first measurement (A) with the brake pedal released.
 - B. Take the second measurement (B) after applying the brake pedal with about 445 N (100 lbs.) of force using a brake pedal effort gage, such as J 28662.
 - C. Subtract measurement A from measurement B.
 - D. Compare the measurement with the specifications below:

Vacuum Booster	80 mm (3.1 inches)
Hydraulic Booster	110 mm (4.3 inches)
Four-Wheel Disc Brakes ..	102 mm (4 inches)
 - E. If brake pedal travel is excessive, refer to the brake system diagnostic chart.

BRAKE FLUID LEAKS

With the engine at idle and the transmission in "Neutral," apply and hold constant foot pressure on the brake pedal. If the pedal gradually falls away, the hydraulic system may have external leakage, internal leakage, or incorrect component adjustment. Begin by performing a visual inspection of the hydraulic system.

Check the master cylinder fluid level. A slightly low brake fluid level in either reservoir can result from normal lining wear. An abnormally low fluid level indicates a leak in the system. A full master cylinder does not always mean there is no leakage. Slight leakage can occur and not appear as a fluid level condition.

- For information on master cylinder fluid levels, refer to SECTION 5A.

If no external leaks are found, an internal leakage condition may be the cause. This relates to an internal master cylinder condition. To diagnose internal leakage, the master cylinder will require disassembly. Refer to the Light Duty Truck Unit Repair Manual.

BRAKE HOSE AND PIPE INSPECTION

Brake hoses and pipes should be inspected at least twice a year for any signs of road damage, cracks, and chafing of the outer cover. Check for fluid leaks and damage at the brake hose and pipe connections. If any of these conditions are visible, replace the hose or pipe. Make sure all mounting hardware is in place and secure. Repair these as needed.

COMBINATION VALVE CIRCUIT TEST

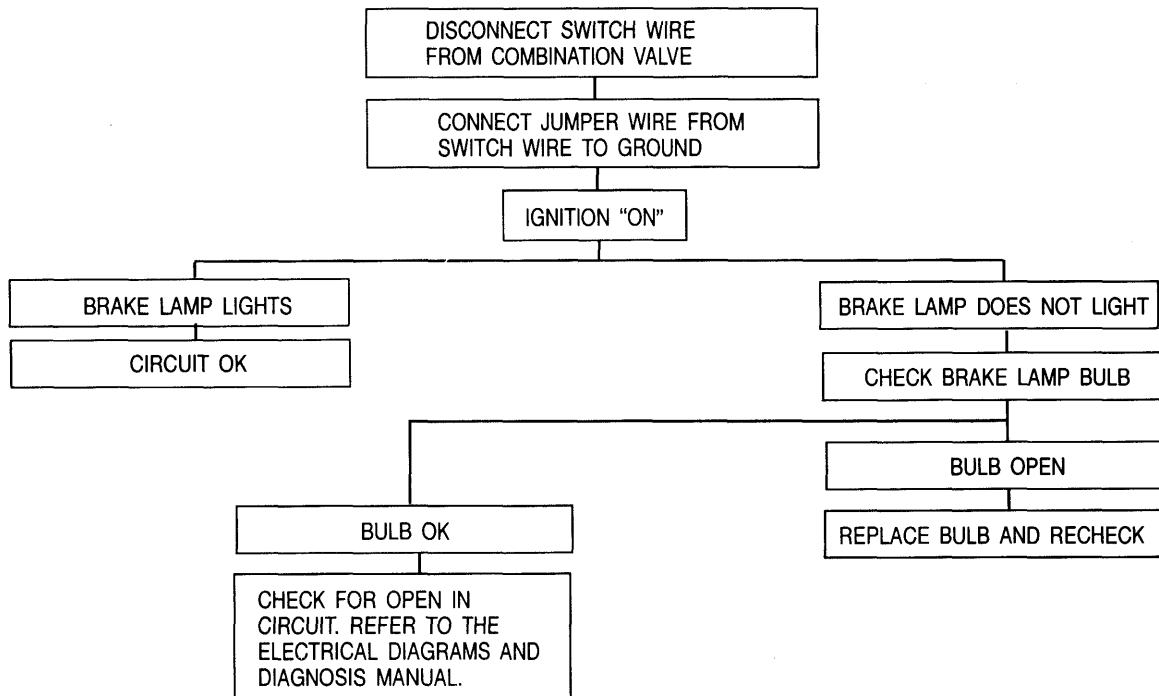
To test the combination valve switch circuit, refer to figure 4.

COMBINATION VALVE WARNING SWITCH TEST

To test the combination valve warning switch, refer to figure 5.

5-6 HYDRAULIC BRAKES

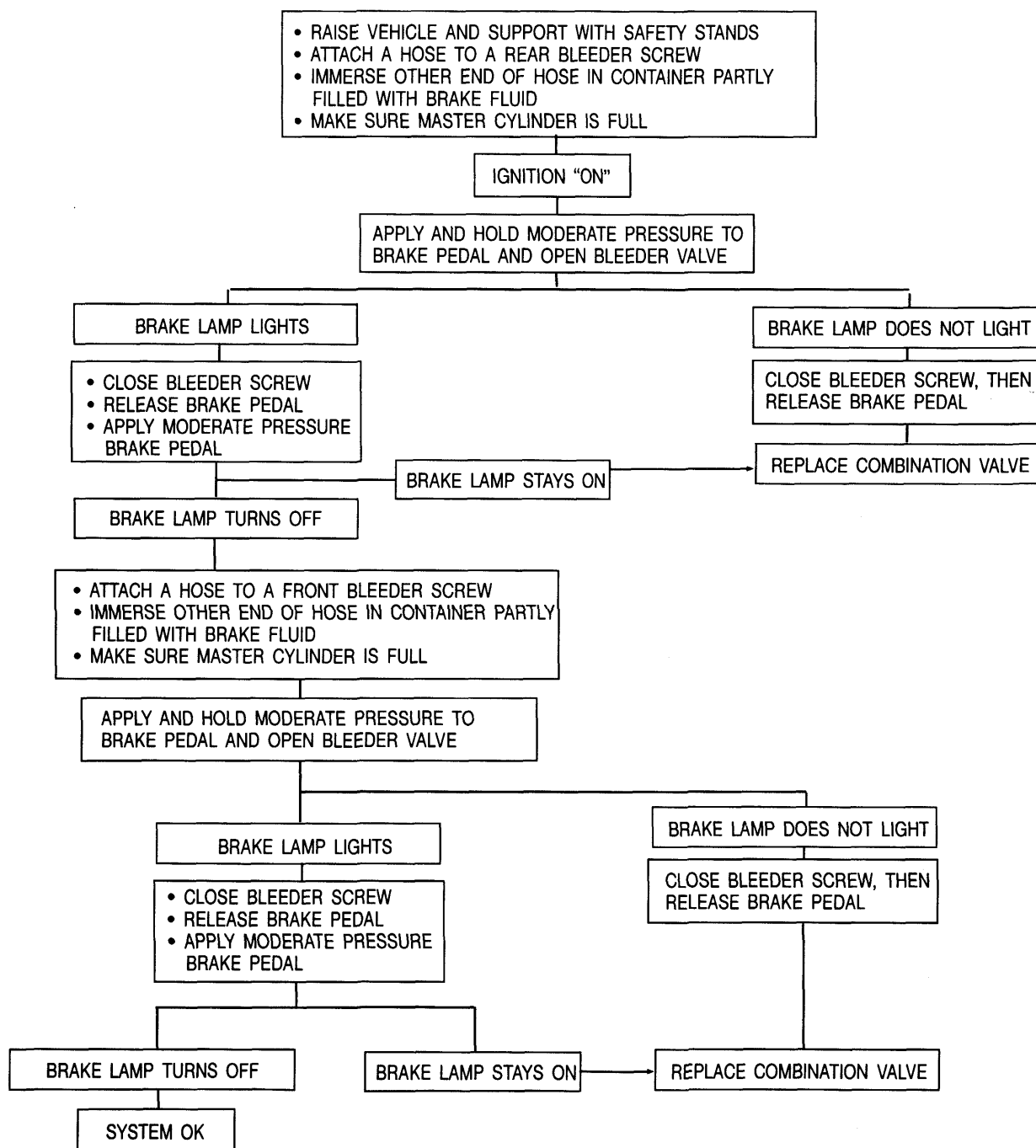
COMBINATION VALVE CIRCUIT TEST



C0180

Figure 4—Combination Valve Circuit Test

COMBINATION VALVE WARNING SWITCH TEST



C0179

Figure 5—Combination Valve Warning Switch Test

5-8 HYDRAULIC BRAKES

BRAKE SYSTEM DIAGNOSIS

For diagnosis of the brake system, refer to figure 6.

BRAKE SYSTEM DIAGNOSIS												
CAUSES	DIAGNOSIS SECTION											
	SYMPTOM	BRAKE PEDAL TRAVEL EXCESSIVE	EXCESSIVE BRAKE PEDAL TRAVEL	EXCESSIVE BRAKING ACTION	UNEVEN BRAKING ACTION	UNEVEN BRAKE PEDAL EFFORT	BINDING HYDRO BOOSTER SPOOL VALVE	BRAKES SLOW TO RESPOND	BRAPING NOISE (SIDE TO SIDE)	BRAPING NOISE (FRONT TO REAR)	"BRAKE" WARNING LAMP "ON"	"BRAKE" WARNING LAMP "OFF"
LEAKING BRAKE PIPE, HOSE, OR CONNECTION	X XX										XX	5
LEAKING PISTON/AXLE SEAL	X XX										X	5B,5C
LEAKING MASTER CYLINDER (INTERNAL)	X XX										X	5A
CONTAMINATED POWER STEERING FLUID							XX					3B
AIR IN BRAKE SYSTEM	XX										XX	5
CONTAMINATED OR IMPROPER BRAKE FLUID	X				X X		X X X				X	5
LEAKING BOOSTER/VACUUM SYSTEM			XX	X								5D1,5D2
RESTRICTED PASSAGE IN BOOSTER	X X		XX X									5D1,5D2
DAMAGED BOOSTER	X X X X	XX										5D1,5D2
WORN OUT BRAKE LINING -REPLACE			X X						X X X X		X	5B,5C
UNEVEN LINING WEAR—REPLACE AND CORRECT CAUSE	X		X						X X X X		X	5B,5C
INCORRECT LINING MATERIAL—REPLACE			X X						X X X			5B,5C
CONTAMINATED BRAKE LINING—REPLACE			X						XX XX X X			5B,5C
LININGS DAMAGED BY ABUSIVE USE—REPLACE			X XX						X X X X		X	5B,5C
HEAT SPOTTED OR SCORED DISCS			X						X X X	XX		5B1,5B2
IMPROPER THICKNESS VARIATION	X X										XX	5B,5C
EXCESSIVE LATERAL RUN-OUT	X X										X	5B,5C
BRAKE ASSEMBLY ATTACHMENTS MISSING OR LOOSE	X		X						X X X X		X	5B,5C
RESTRICTED BRAKE FLUID PASSAGE	X X	X X							X X X			5
IMPROPERLY ADJUSTED CRUISE CONTROL VACUUM DUMP									X			5
BRAKE PEDAL OR LINKAGE INTERFERENCE (BINDING)		X	X XX	XX								5
IMPROPERLY ADJUSTED PARKING BRAKE									X X X			5F
INCORRECT FRONT END ALIGNMENT									XX			3A
INCORRECT TIRE PRESURE									X			0A
LOOSE FRONT SUSPENSION ATTACHMENTS									X X XX		X	3C
OUT-OF-BALANCE WHEEL ASSEMBLIES											XX	3E
OPERATOR RIDING BRAKE PEDAL		X							X			-
STICKING CALIPER OR CALIPER PISTONS			X X	XX	X X							5B1,5B2
PARK BRAKE SWITCH CIRCUIT GROUNDED											XX	8A
PARK BRAKE NOT RELEASING				X					X		XX	5F
ROTOR OR DRUM SURFACE FINISH		X							X X		X	5B,5C
IMPROPER REAR BRAKE ADJUSTMENT	X								X		X	5C
LOW ENGINE VACUUM		X	X									6A
DAMAGED COMBINATION VALVE					X				X		X	5
RESTRICTED POWER STEERING HOSE TO BOOSTER			X									5D2
VEHICLE LOADING	X X								XX			5
ANTILOCK BRAKE SYSTEM INVOLVEMENT	XX X								X		X	5E

3005r3359

Figure 6—Brake System Diagnosis

ON-VEHICLE SERVICE

FILLING MASTER CYLINDER RESERVOIR

For information on filling the master cylinder reservoir, refer to SECTION 5A.

BRAKE PEDAL

Remove or Disconnect (Figure 7)

1. Electrical connector from stoplamp switch.
2. Retainer.
3. Bushing.
4. Pushrod.
5. Nut.
6. Bolt.
7. Bushings and spacer.
8. Brake pedal.

Install or Connect (Figure 7)

1. Brake pedal.
2. Bushings and spacer.
3. Bolt.

NOTICE: Refer to "Notice" on page 5-1.

4. Nut.



Tighten

- Bolt to 47 N.m (35 lbs. ft.).

5. Pushrod.
6. Bushing.
7. Retainer.
8. Electrical connector.

STOPLAMP SWITCH

For further information on stoplamp circuit diagnosis, refer to SECTION 8B and the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.



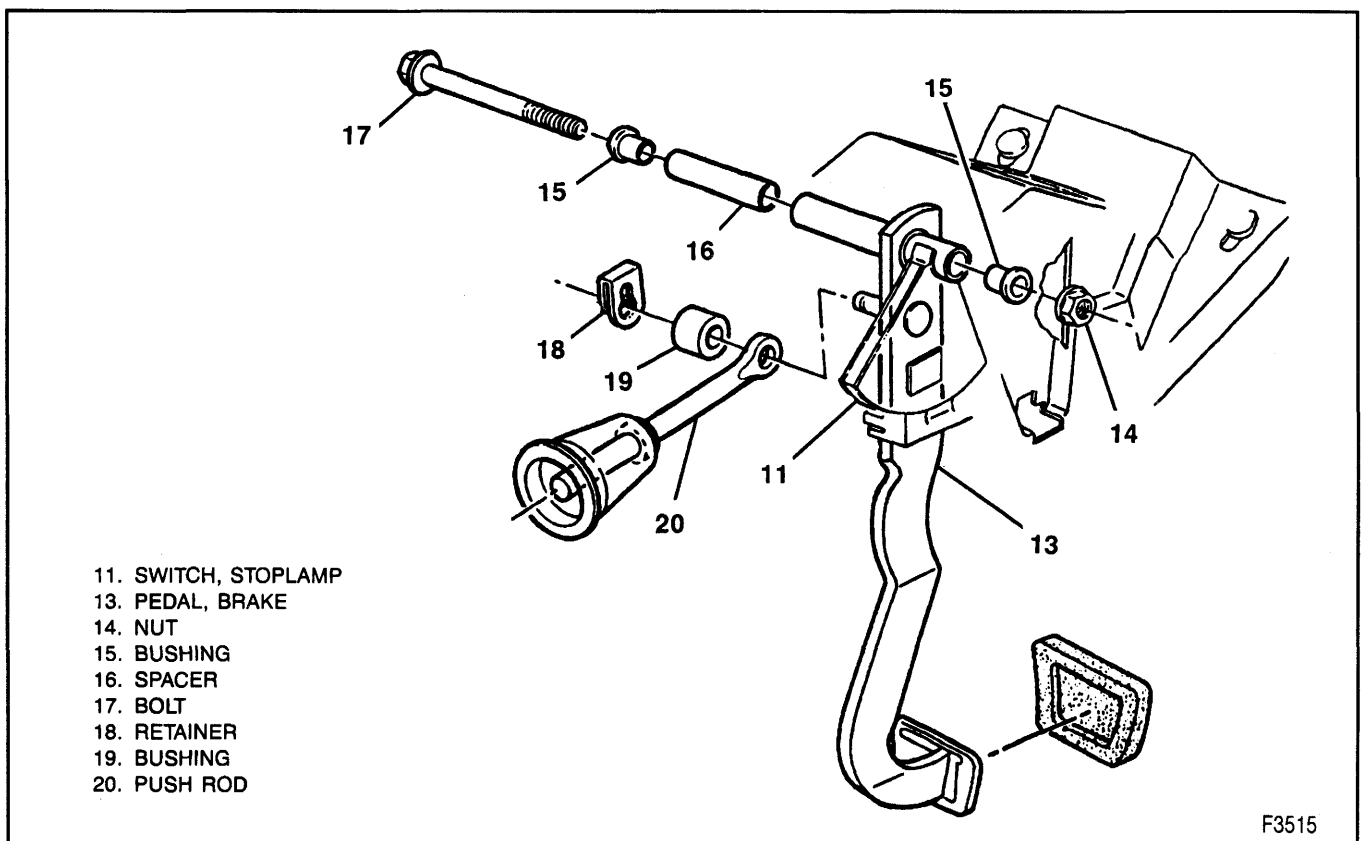
Remove or Disconnect (Figure 8)

1. Negative battery cable. Refer to SECTION 0A.
2. Retainer from brake pedal pin.
3. Switch by unsnapping from pushrod.
4. Electrical connector from switch.



Install or Connect (Figure 8)

1. Electrical connector into switch.
2. Switch by snapping it onto pushrod.
3. Retainer onto brake pedal pin.
4. Negative battery cable.



F3515

Figure 7—Brake Pedal

5-10 HYDRAULIC BRAKES

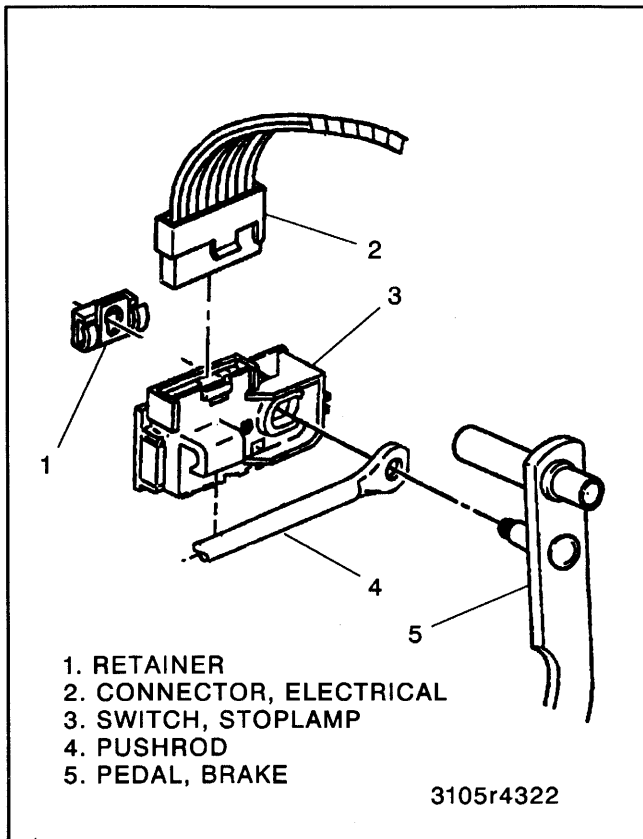


Figure 8—StopLamp Switch

PIPES, HOSES, AND FITTINGS

PIPE REPLACEMENT

CAUTION: Always use double-walled steel brake pipe when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and brake system failure.

Brake pipes that run parallel to each other must maintain a 6-mm (1/4-inch) clearance.

HOSE REPLACEMENT



Clean

- Dirt, grease, and other foreign material from the hose fittings at both ends.



Remove or Disconnect (Figure 9)

1. Steel pipe.
2. Clip or nut.
3. Bolt.
4. Washers.
5. Hose.



Install or Connect (Figure 9)

- Use new copper washers when installing the hose.
1. Hose.
 - The hose must not be twisted or contact any suspension components.
 2. Washers.
 3. Bolt.
 4. Clip or nut.
 5. Steel pipe.
 6. Bleed brakes. Refer to "Bleeding Brake Hydraulic System."

COMBINATION VALVE

NOTICE: Brake fluid can damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.



Remove or Disconnect (Figure 10)

- The combination valve is not repairable and must be replaced as an assembly.
1. Hydraulic pipes.
 - Plug the pipes to prevent the loss of fluid or entrance of dirt.
 2. Warning switch connector.
 3. Electric brake control module if used.
 4. Bolts.
 5. Antilock pressure valve if used.
 6. Nuts.
 7. Bracket and combination valve.



Install or Connect (Figure 10)

NOTICE: For steps 2, 4, and 7, refer to "Notice" on page 5-1.

1. Bracket and combination valve.
2. Nuts.



Tighten

- Nuts to 36 N.m (26 lbs. ft.).
3. Antilock pressure valve if used.
 4. Bolts.



Tighten

- Bolts to 29 N.m (21 lbs. ft.).
5. Electric brake control module if used.
 6. Warning switch connector.
 7. Hydraulic pipes.



Tighten

- Fittings to 24 N.m (18 lbs. ft.).
8. Bleed system. Refer to "Bleeding Brake Hydraulic System."

HEIGHT-SENSING BRAKE PROPORTIONING VALVE

Remove or Disconnect (Figure 11)

1. Raise vehicle and support it at suitable frame locations to allow rear axle to hang freely.
2. Height sensing bracket from bracket assembly.
3. Nut.
4. Lever assembly from valve assembly.
5. Brake pipes.
6. Bolts and washers.
7. Valve assembly.

Install or Connect (Figure 11)

1. Valve assembly.

NOTICE: Refer to "Notice" on page 5-1.

2. Bolts and washers.

Tighten

- Bolts to 27 N.m (20 lbs. ft.)

3. Brake pipes.

Tighten

- Fittings to 24 N.m (18 lbs. ft.)

Important

- The rear axle must be hanging freely or the valve adjustment will be incorrect.

Adjust

- Valve Assembly. Refer to "Height-Sensing Brake Proportioning Valve Adjustment."

4. Bracket to height sensing bracket assembly.
5. Bleed brakes. Refer to "Bleeding Brake Hydraulic System."
6. Lower vehicle and test brakes.

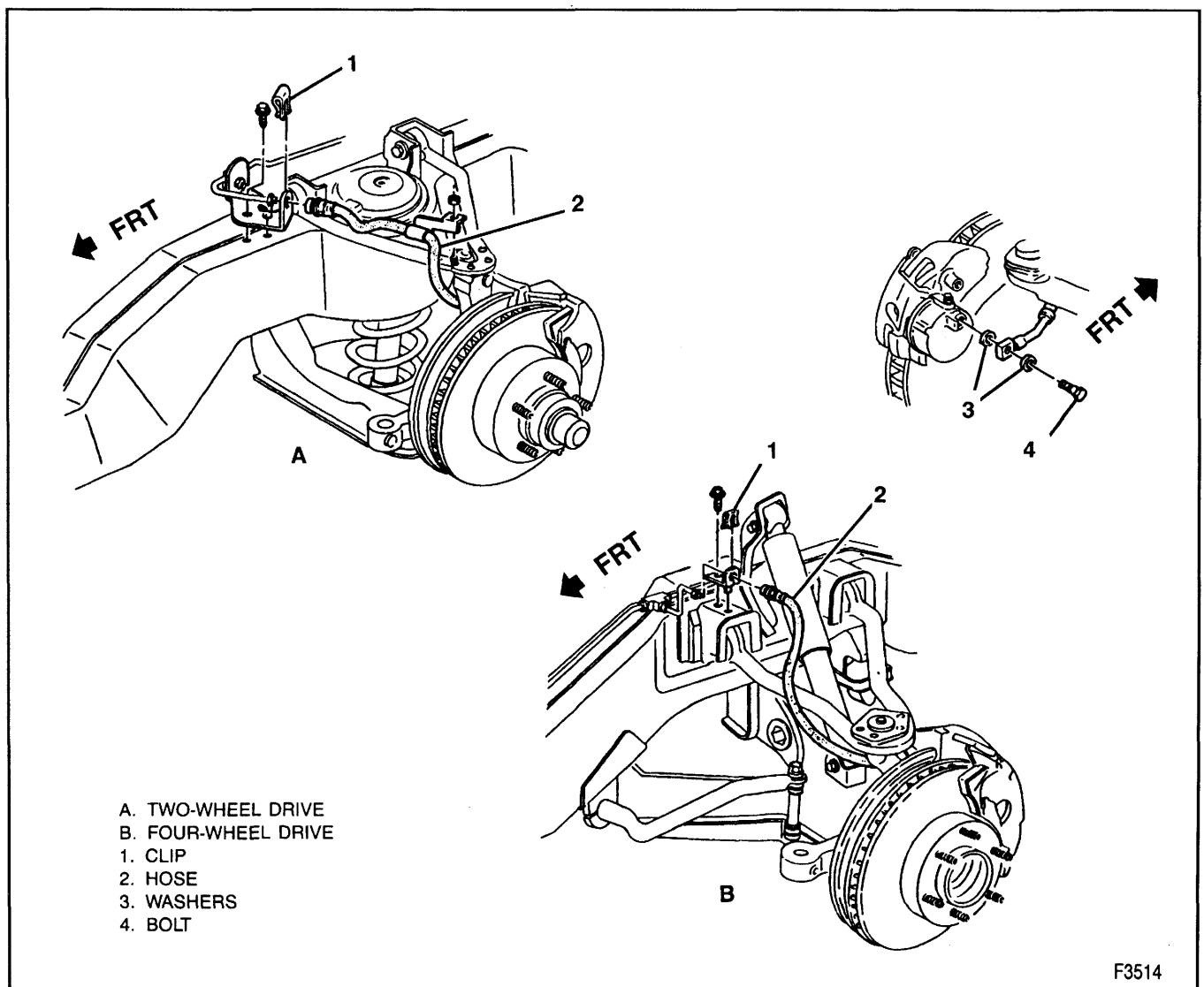
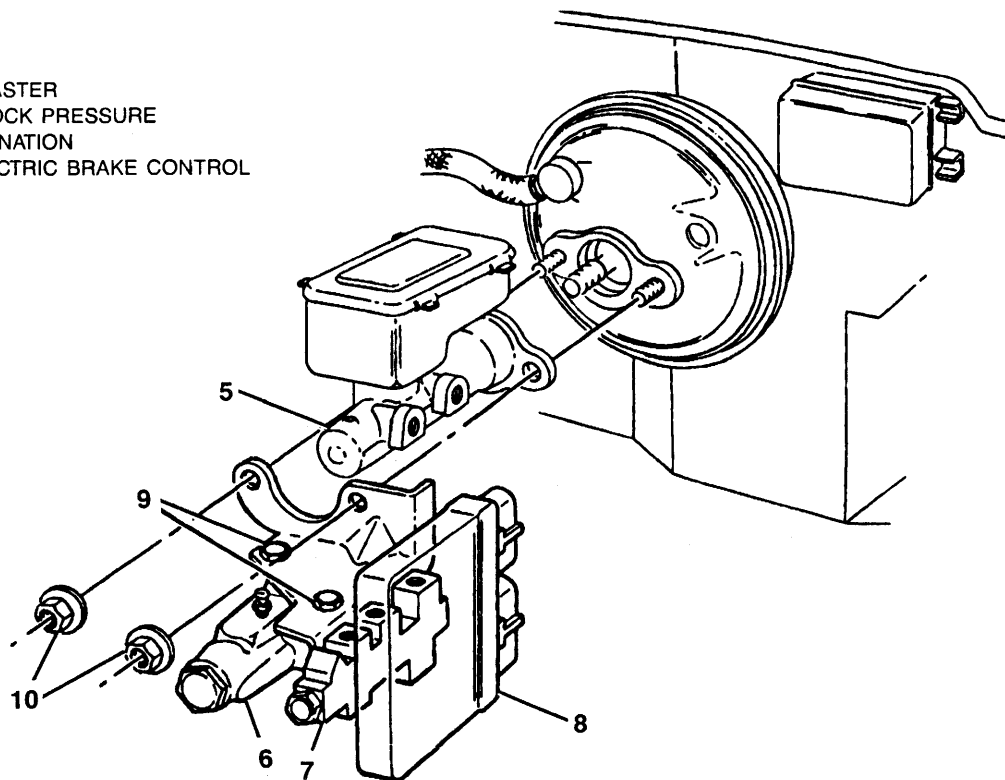


Figure 9—Flexible Hose

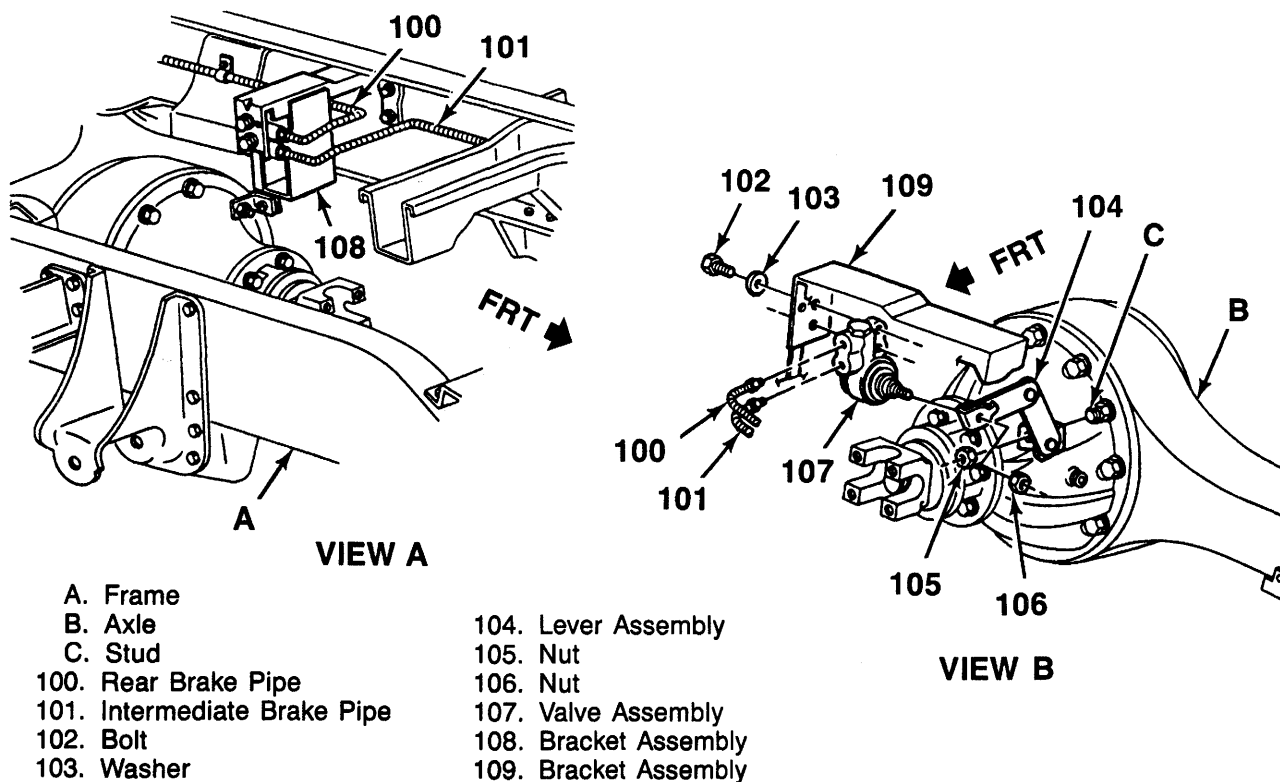
5-12 HYDRAULIC BRAKES

- 5. CYLINDER, MASTER
- 6. VALVE, ANTILOCK PRESSURE
- 7. VALVE, COMBINATION
- 8. MODULE, ELECTRIC BRAKE CONTROL
- 9. BOLTS
- 10. NUTS



F3451

Figure 10—Combination Valve



F9541

Figure 11—Height-Sensing Proportioning Valve

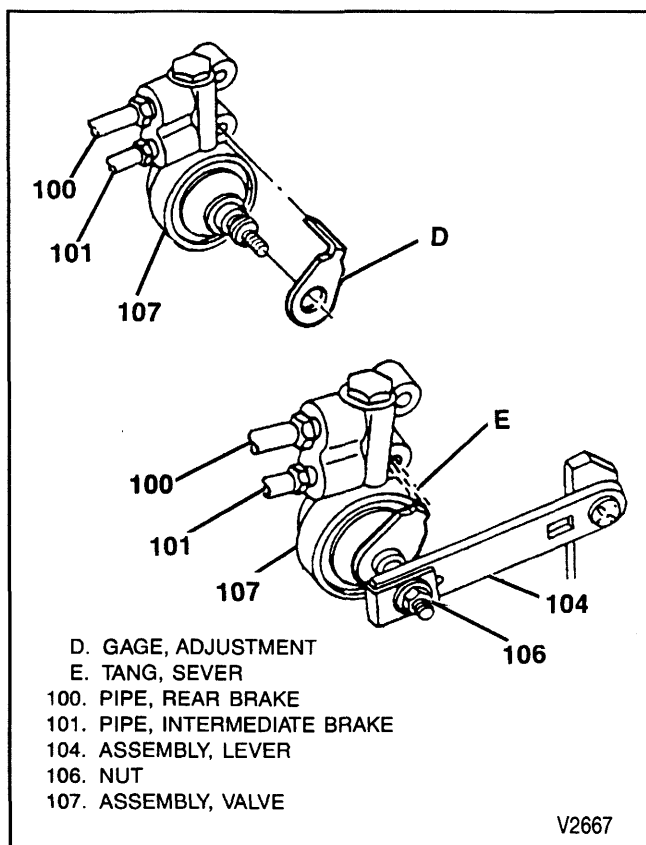


Figure 12—Height-Sensing Proportioning Valve Adjustment

HEIGHT-SENSING BRAKE PROPORTIONING VALVE ADJUSTMENT

Refer to figure 12.

1. Raise vehicle.
 - Allow axle to hang freely.
2. Remove nut and lever assembly from valve.
3. Rotate valve shaft to allow installation of plastic adjustment gage (GM P/N 15592484).
 - The "D" shaped center hole must seat over valve shaft and gage tang must be positioned in valve mounting hole.
4. Install lever assembly to valve shaft with a C-clamp or locking pliers to seat lever nylon bushing on serrated valve shaft.



Important

- Do not install the lever using the attaching nut. Doing so can result in improper valve adjustment.

NOTICE: Refer to "Notice" on page 5-1.

5. Install valve shaft nut.



Tighten

- Nut to 9 N.m (80 lbs. in.)
6. Cut tang from body of adjustment gage to allow valve to rotate freely.
 7. Lower vehicle and test brakes.

BLEEDING BRAKE HYDRAULIC SYSTEM

Bleeding is necessary if air has entered the hydraulic brake system.

It may be necessary to bleed the system at all four wheels if a low fluid level allowed the air to enter the system or the brake pipes have been disconnected at the master cylinder or combination valve. If a pipe is disconnected at one wheel, then bleed only that wheel.

The time required to bleed the hydraulic system when the master cylinder is removed can be reduced by bench bleeding the master cylinder before installing it on the vehicle.

MANUAL BLEEDING

If the vehicle is equipped with a vacuum booster, relieve the vacuum reserve by applying the brakes several times with the engine off.

NOTICE: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent the brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

1. Fill the master cylinder reservoir with Delco Supreme No. 11 Hydraulic Brake Fluid (GM P/N 1052535) or an equivalent DOT 3 motor vehicle brake fluid.
 - Maintain the fluid level during bleeding.
2. If the master cylinder is suspected to have air in the bore, bleed it before any wheel cylinder or caliper.
 - A. Disconnect the forward brake pipe connection at the master cylinder.
 - B. Allow the brake fluid to flow from the connector port.
 - C. Connect the brake pipe but do not tighten.
 - D. Slowly apply the brake pedal and allow the air to bleed from the loose fitting.
 - E. Tighten the fitting before releasing the pedal.
 - F. Wait 15 seconds.
 - G. Repeat this sequence, including the 15-second wait, until all air is purged from the bore.
 - H. After all air has been removed from the forward connection, repeat this procedure for the rear pipe.
3. If the BPMV of the 4WAL system is replaced or suspected to have air trapped inside, it must be bled next. Refer to SECTION 5E1.
4. Bleed each wheel in the following sequence:
 - A. Right rear.
 - B. Left rear.
 - C. Right front.
 - D. Left front.
5. Attach a hose to the wheel cylinder/caliper bleeder valve.
 - Immerse the opposite end of the hose into a container partially filled with clean brake fluid (figure 13).
6. Slowly apply the brake pedal one time and hold.

5-14 HYDRAULIC BRAKES

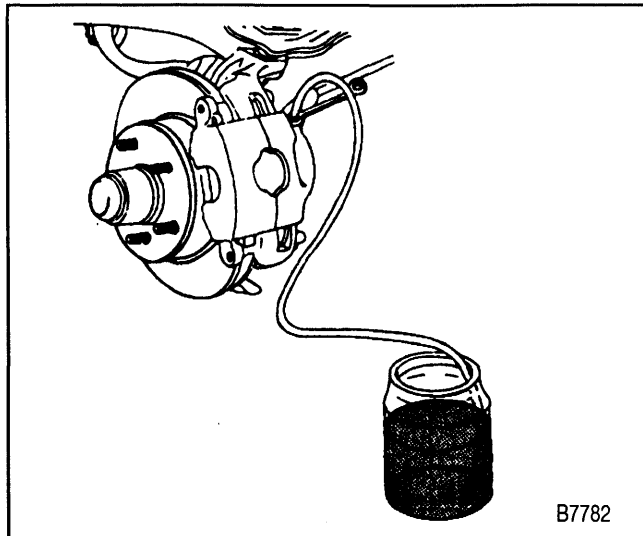


Figure 13—Immersing the Bleeder Hose

7. Loosen the bleeder valve to purge the air from the wheel cylinder/caliper.
8. Tighten the bleeder valve to 7 N·m (62 lbs. in.) and slowly release the pedal.
9. Wait 15 seconds.
10. Repeat this sequence, including the 15-second wait, until all air is purged from the wheel cylinder/caliper.
11. Repeat steps 5 through 10 at each wheel until the system is bled.
12. Check the brake pedal for “sponginess” and the brake warning lamp for an indication of unbalanced pressure. Repeat the bleeding procedure to correct either of these conditions.

PRESSURE BLEEDING

A diaphragm type pressure bleeder must be used. It must have a rubber diaphragm between the air supply and brake fluid to prevent air, moisture, oil, and other contaminants from entering the hydraulic system.

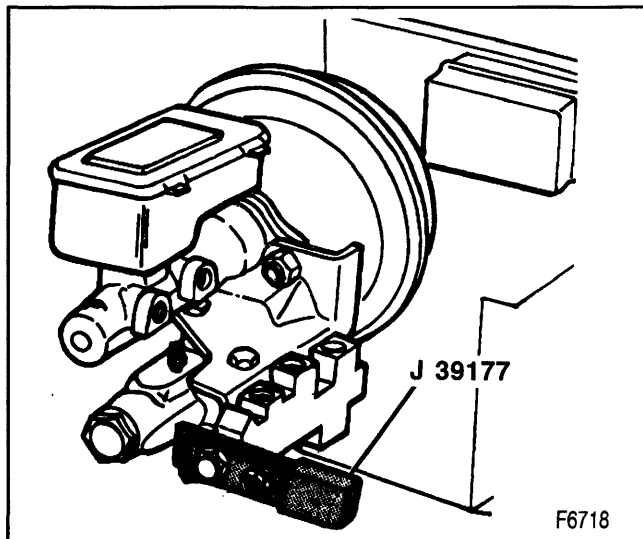


Figure 14—Combination Valve Pressure Bleeding Tool

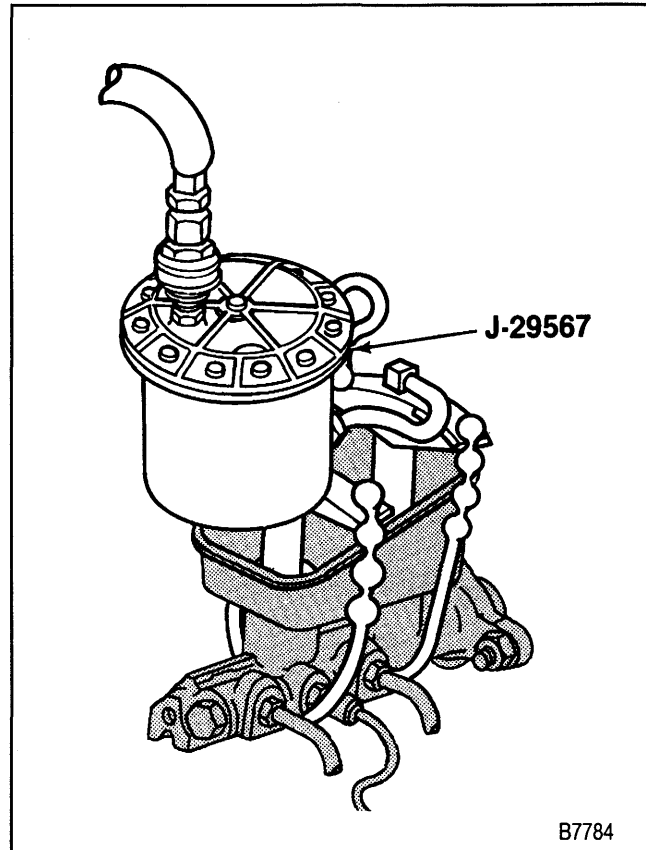


Figure 15—Reservoir Bleeder Adapter

NOTICE: Brake fluid can damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

Tools Required:

- J 29567 Brake Bleeder Adapter (Plastic Reservoir)
 - J 23518-01 Brake Bleeder Adapter (Cast-Iron Reservoir)
 - J 39177 Combination Valve Pressure Bleeding Tool
1. Fill the pressure tank at least 2/3 full of brake fluid.
 - The bleeder must be bled each time fluid is added.
 2. Charge the bleeder to 140-170 kPa (20-25 psi).
 3. Use J 39177 to depress and hold the valve stem on the combination valve (figure 14).
 4. Install the bleeder adapter (figure 15).
 5. If the BPMV of the 4WAL system is replaced or suspected to have air trapped inside, it must be bled next. Refer to SECTION 5E1.
 6. Bleed each wheel in the following sequence:
 - A. Right rear.
 - B. Left rear.
 - C. Right front.
 - D. Left front.
 7. Connect the hose from the bleeder to the adapter at the master cylinder.
 8. Open the tank valve.

9. Attach a hose to the bleeder valve.
 - Immerse the opposite end of the hose into a container partially filled with clean brake fluid.
10. Open the bleeder valve at least 3/4 of a turn and allow the fluid to flow until no air is seen in the fluid.
11. Tighten the bleeder valve to 7 N.m (62 lbs. in.).
12. Repeat steps 9 through 11 at all wheels.
13. Check the brake pedal for "sponginess."
 - Repeat the entire bleeding procedure if this condition is found.
14. Remove J 39177.
15. Disconnect the hose from the bleeder adapter.
16. Remove the bleeder adapter.
17. Fill the master cylinder to the proper level.

FLUSHING BRAKE HYDRAULIC SYSTEM

Flushing is done at each bleeder valve similar to the bleeding procedure. The difference is that the bleeder valve is opened 1 1/2 turns and fluid is forced through the pipes, hoses, and bleeder valves until it comes out clear in color. Refer to "Bleeding Brake Hydraulic System."

Check the master cylinder fluid level after flushing at each bleeder valve and refill as required. After flushing, make sure the master cylinder reservoir is filled to the correct level.

SPECIFICATIONS BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 2.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

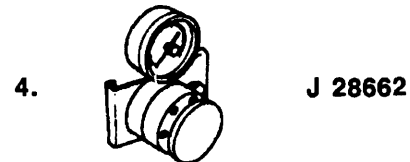
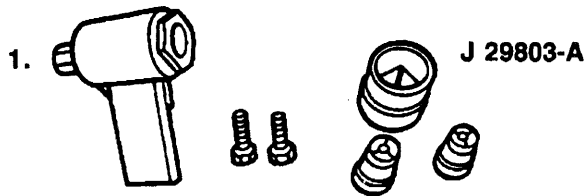
T2112

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Lbs. Ft.	Lbs. In.
Antilock Pressure Valve Bolts.....	29	21	—
Brake Pedal Through Bolt	47	35	—
Brake Pipe Clip Bolts.....	17	13	—
Brake Pipe Fittings.....	24	18	—
Bleeder Valves.....	7	—	62
Front Brake Hose to Caliper Bolt.....	44	32	—
Height-Sensing Proportioning Valve Lever Nut.....	9	—	80
Height-Sensing Proportioning Valve Mounting Bolts	27	20	—
Master Cylinder Mounting Nuts	36	26	—

T2113

SPECIAL TOOLS



- 1. FLARING TOOL
- 2. COMBINATION VALVE PRESSURE BLEEDING TOOL
- 3. BRAKE BLEEDER ADAPTER
- 4. BRAKE PEDAL EFFORT GAGE
- 5. WHEEL CYLINDER BLEEDER WRENCH

2905r0080

SECTION 5A

MASTER CYLINDER

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

MASTER CYLINDER

The master cylinder (figure 1) is designed for a system using low-drag calipers. In addition to the standard master cylinder functions, a quick take-up feature is included on models with a vacuum booster. This provides a large volume of low pressure fluid to the wheels with the initial brake application. The large volume of fluid helps overcome the clearance created by the caliper pistons and rear brake shoes retracting.

RESERVOIR AND COVER

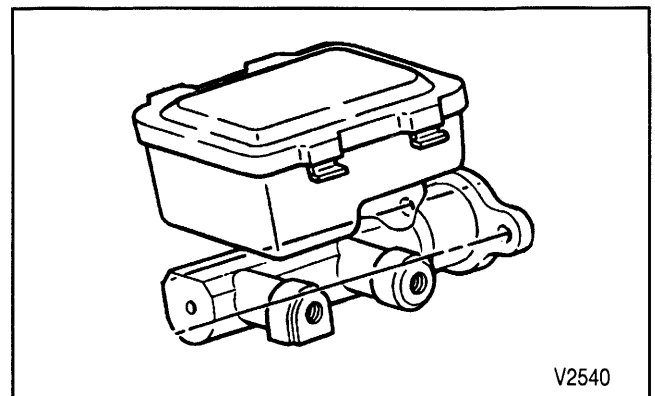
The reservoir and cover used on these models are made of plastic. The cover snaps onto the top of the reservoir. A seal is located between the cover and reservoir to keep contaminants out of the brake fluid.

The master cylinder reservoir must be kept properly filled. This ensures adequate reserve fluid and prevents air from entering the hydraulic system. Fluid expansion due to heat absorbed from the brakes and engine makes it important that the reservoirs not be overfilled.

FLUID AND FLUID HANDLING

CAUTION: Brake fluid may be irritating to skin or eyes. In case of contact, take the following actions:

- Eye contact - rinse eyes thoroughly with water.
- Skin contact - wash skin with soap and water.



V2540

Figure 1—Master Cylinder

5A-2 MASTER CYLINDER

NOTICE: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

Use Delco Supreme 11 Brake Fluid (GM P/N 1052535) or an equivalent DOT-3 motor vehicle brake fluid.

Brake fluid should always be stored in a closed container. Re-seal brake fluid containers immediately after use. Brake fluid left in an open or improperly sealed container will absorb moisture. This can lower the fluid's boiling point and result in system contamination, corrosion, or deterioration of rubber components.

SUBSTANDARD OR CONTAMINATED FLUID

NOTICE: Power steering fluid and brake fluid cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.

No special fluids are used in this system. However, care must be taken to use the correct fluids on models with a hydraulic booster. The master cylinder and brake system uses brake fluid, while the hydraulic booster system uses power steering fluid.

Improper fluid, water, or any other contaminants in the fluid may cause the brake fluid to boil or rubber component deterioration in the hydraulic system.

Swollen master cylinder piston seals show that rubber deterioration has occurred. Rubber deterioration is also shown by swollen wheel cylinder boots, caliper boots, or the master cylinder reservoir diaphragm.

If rubber deterioration is found, replace all rubber parts in the system, including the hoses. Also check for fluid on the brake linings. If any is found, replace the linings.

If the brake fluid is contaminated and the master cylinder piston seals are satisfactory, check for leaks or excessive heat conditions. If no leaks or excessive heat conditions are found, flush the system. Refer to SECTION 5 for the procedure.

DIAGNOSIS

MASTER CYLINDER

These tests will not find all master cylinder malfunctions. If the cause is not found with these tests, refer to the brake system diagnostic chart in SECTION 5 for additional information.

1. Check for a cracked casting or brake fluid leaks around the master cylinder.
 - Leaks are indicated only if there is at least a drop of fluid. A damp condition is not abnormal.

2. Check for binding pedal linkage and incorrect push-rod length.
 - Disassemble the master cylinder if there is no brake pedal binding or improper brake pedal travel. Refer to the Light Duty Truck Unit Repair Manual.
3. Check the master cylinder for swollen or elongated primary piston seal(s).
 - If swollen seals are found, refer to "Substandard or Contaminated Fluid."

ON-VEHICLE SERVICE

FILLING MASTER CYLINDER RESERVOIR

NOTICE: Do not use fluid that has a petroleum base. Do not use a container that has been used for petroleum based fluids or is wet with water. Petroleum based fluids cause swelling and distortion of rubber parts in the hydraulic brake system and water lowers the brake fluid's boiling point. Keep all fluid containers capped to prevent contamination.

Thoroughly clean the top of reservoir cover before removal. This helps prevent dirt from getting into the reservoirs. Remove the cover and diaphragm and add fluid as required to bring the level to the full mark (typically located inside the reservoir). Use Delco Supreme No. 11 Hydraulic Brake Fluid (GM P/N 1052535) or an equivalent DOT 3 motor vehicle brake fluid.

MASTER CYLINDER ASSEMBLY



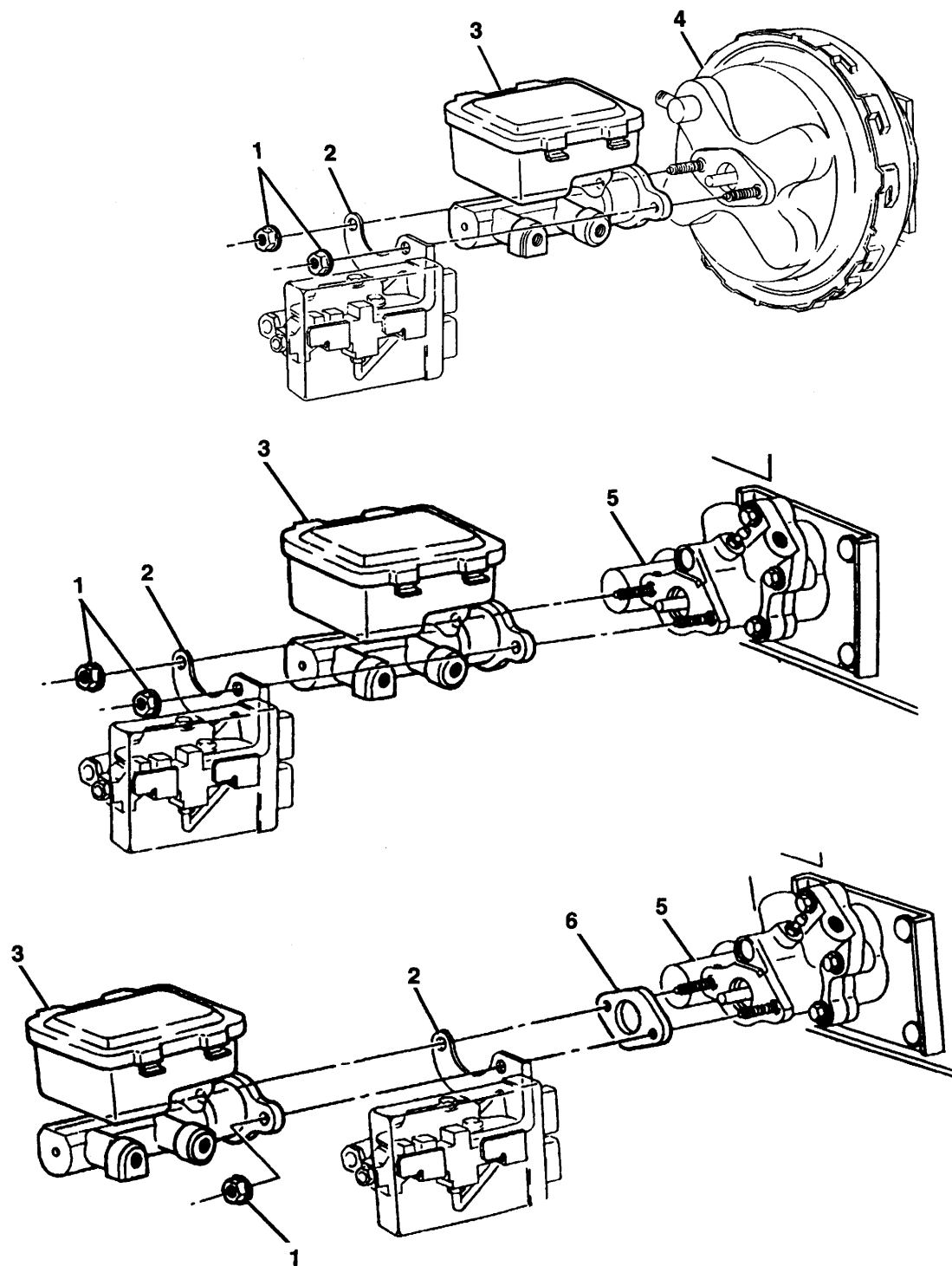
Remove or Disconnect (Figure 2 or 3)

- Apply parking brake.
1. Brake pipes.
 - Cover the ends of the pipes to prevent dirt from entering the system.
 - Do not allow brake fluid to fall on the EBCM, connectors, or wiring (vehicles with RWAL brakes only).
 2. Nuts (1).
 3. Master cylinder (3) and bracket (2).



Install or Connect (Figure 2 or 3)

NOTICE: For steps 2 and 3, refer to "Notice" on page 5A-1.



- 1. NUTS, 27 N·m (20 FT. LBS.)
- 2. BRACKET
- 3. CYLINDER, MASTER
- 4. BOOSTER, VACUUM
- 5. BOOSTER, HYDRAULIC
- 6. SPACER

V2620

Figure 2—Master Cylinder (RWAL)

5A-4 MASTER CYLINDER

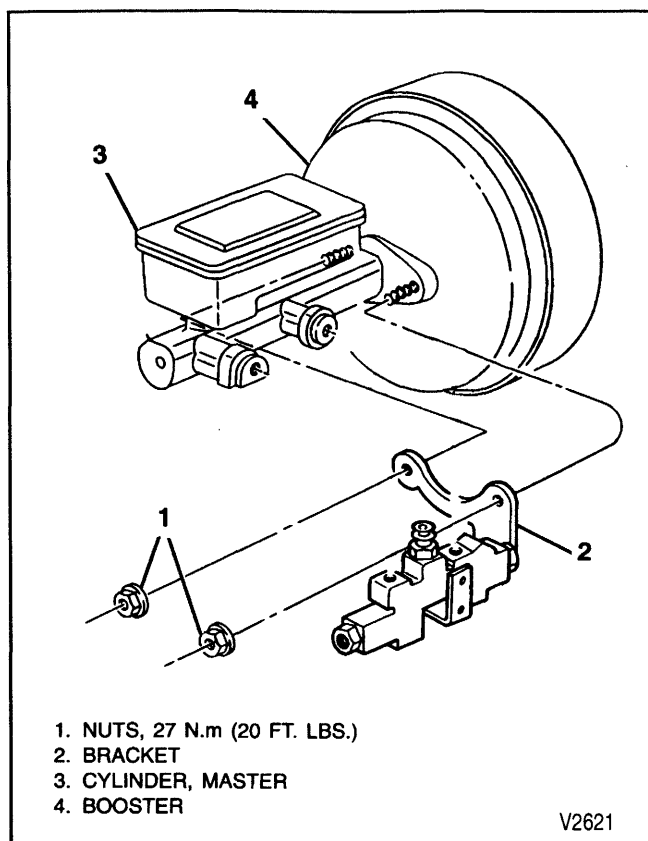


Figure 3—Master Cylinder (4WAL)

- Prior to installation, refer to "Bench Bleeding."
- 1. Master cylinder (3) and bracket (2).
- 2. Nuts (1).



Tighten

- Nuts (1) to 36 N.m (27 lbs. ft.).
- 3. Brake pipes.



Tighten

- Brake pipe fittings to 27 N.m (20 lbs. ft.).
- Bleed brakes. Refer to SECTION 5.
- Release parking brake.

BENCH BLEEDING

The purpose of bench bleeding the master cylinder is to remove the air from it prior to installation. This reduces the amount of bleeding needed after it is installed on the vehicle.

1. Plug the outlet ports and mount the master cylinder in a vise with the front end tilted slightly down.
2. Fill the reservoir with clean brake fluid.
3. Using a tool with a smooth rounded end, stroke the primary piston about 25 mm (1 inch) several times.
 - As air is bled from the master cylinder, the primary piston will not travel the full 25-mm (1-inch) stroke.
4. Reposition the master cylinder in the vise with the front end tilted slightly up.
5. Again stroke the primary piston about 25 mm (1 inch) several times.
6. Reposition the master cylinder in the vise to the level position.
7. Loosen the plugs one at a time and push the piston into the bore to force the air from the cylinder.
 - To prevent air from being sucked back into the cylinder, tighten the plug(s) before allowing the piston to return to its original position.
8. Fill the reservoir.
 - Perform normal bleeding procedures after the master cylinder is installed. Refer to "Bleeding System."

BLEEDING SYSTEM

For information on bleeding the brake hydraulic system, refer to SECTION 5.

SPECIFICATIONS

BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 2.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

FASTENER TIGHTENING SPECIFICATIONS

	N.m	Lbs. Ft.
Brake Pipe Fittings.....	27	20
Master Cylinder Mounting Nuts	36	27

T2905

SECTION 5B1

FRONT DISC BRAKES

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, by cleaning brake parts with a dry brush or with compressed air. Many earlier models or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: Any new rotor must have the protective coating removed from the friction surfaces before being placed in service. Use Goodwrench Brake Parts Cleaner (GM P/N 12345754) or equivalent, and wipe the surface clean with clean cloths. Do not use gasoline, kerosene, or other oil base solvents which may leave an oily residue. This residue is damaging to brake linings and flammable.

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GENERAL DESCRIPTION

The disc brake assembly consists of a caliper assembly, rotor, and pads mounted to the steering knuckle. The caliper mounts in a way that allows it to move laterally against the rotor. The caliper is a one-piece casting with the inboard side containing the piston bore. A square cut rubber seal fits in a groove in the piston bore to provide a hydraulic seal and return mechanism for the piston.

Applying the brake pedal causes hydraulic pressure to move the piston. The piston then forces the inboard brake pad against the inboard braking surface of the rotor. Increasing the force against the rotor causes the caliper assembly to move inboard. The outer brake pad then contacts the outboard braking surface of the rotor. The force of the two brake pads provides the desired clamping action on the rotor.

Releasing the brake pedal relieves the pressure applied to the piston. The square cut seal on the piston returns to its normal position, allowing a running clearance between the brake pads and rotor.

Servicing Information

- Replace all components included in the repair kits.
- Lubricate the parts as specified.
- Do not use lubricated shop air on brake parts. Rubber component damage may result.
- After any hydraulic component has been removed or disconnected, if necessary, bleed all or part of the brake system.
- Replace brake pads in axle sets only.
- The torques specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench free from mineral oil and any other contaminants.

- Use extreme care when doing any work around the antilock components to prevent damage or misalignment.
- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal has been obtained. Check the brake fluid level in the master cylinder after pumping the brakes.

ROTOR

The front disc brakes use one of four different styles of rotors. The smaller two wheel drive models (C1, C2, and C3) use standard 1.250 inch rotors. The heavy duty two wheel drive model (C30 HD) has four wheel disc brakes with 1.5 inch rotors. The smaller four wheel drive models (K1 and K2) use a composite rotor. The composite rotor requires brake rotor turning tool J 39441 for refinishing. The larger four wheel drive models (K2 and K3) use 1.250 inch rotors on single wheel models and 1.5 inch rotors on dual wheel models. These are three-piece assemblies consisting of a rotor, bearings, and hub. Models with dual rear wheels (R05) use a four-piece rotor assembly consisting of a rotor, bearings, hub, and extension.

CALIPER

Three different types of calipers are used on these models. Delco 3400 calipers with 75 and 80 mm single bores are used on models with a 9600 or lower GVW rating. Delco 3486 calipers with an 86 mm single bore is used on models with 10,000, 11,000, and 12,000 GVW ratings. A Bendix single bore caliper is used on the C30 HD model.

The Delco caliper mounts to the support bracket using two bolts. The Bendix caliper mounts to the support bracket using a support key, spring, and bolt assembly.

DIAGNOSIS

LINING INSPECTION

Inspect the brake linings every 6,000 miles and any time the wheels are removed (tire rotation, etc.). Check both ends of the outer lining by looking in at each end of the caliper (figure 1). These are the points where the highest rate of wear normally occurs. At the same time, check the thickness of the inner lining to make sure it has not worn prematurely. Some inboard shoe and linings have a thermal layer against the shoe, integrally molded with the lining. This extra layer should not be confused with uneven inboard-outboard lining wear. Look down through the inspection hole in the top of the caliper to view the inner lining. Replace disc brake shoe and lining assemblies whenever the thickness of any lining is worn to within 0.76 mm (0.030 in.) of the shoe. Replace riveted shoe and lining assemblies when the lining is worn to within 0.76 mm (0.030 in.) of any rivet head. Always replace disc brake shoe and lining assemblies as a complete axle set.

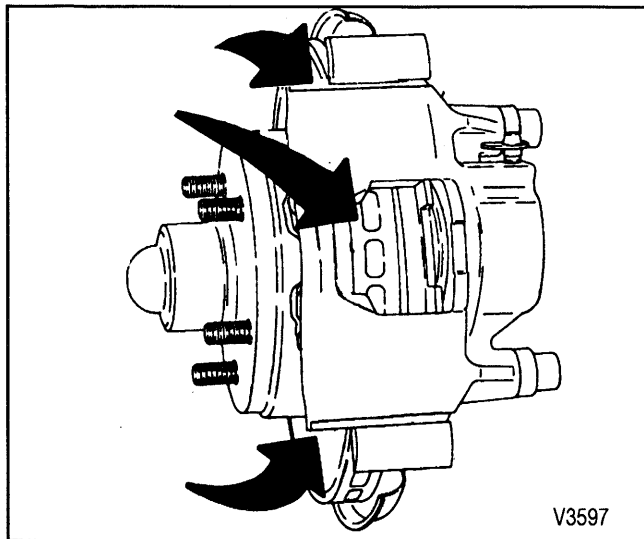
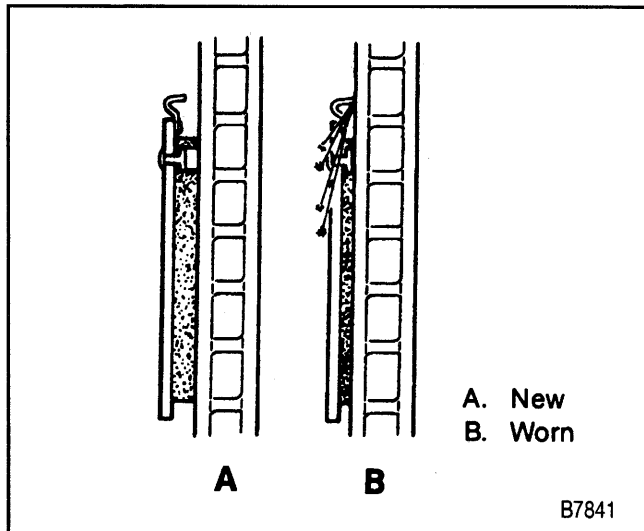
Check the flatness of the brake pads. Place the inboard and outboard lining surfaces together and check for a gap between the lining surfaces. The gap should not exceed 0.13 mm (.005 inch) at the middle of the lining surfaces. This measurement applies to new or used shoe and lining assemblies.

The disc brake shoe and lining assemblies have a wear indicator that contacts the rotor to make noise when the linings wear to the point of needing replacement (figure 2). A loud scraping sound can be heard when this occurs.

ROTOR INSPECTION

ROTOR TOLERANCE AND SURFACE FINISH

During the manufacture of the brake rotor, tolerances of the braking surfaces for flatness, parallelism, and lateral runout are closely held. The maintenance of close tolerances on the shape of the braking surfaces is necessary to prevent brake roughness or pulsation.


Figure 1—Lining Inspection Points

Figure 2—Wear Indicator

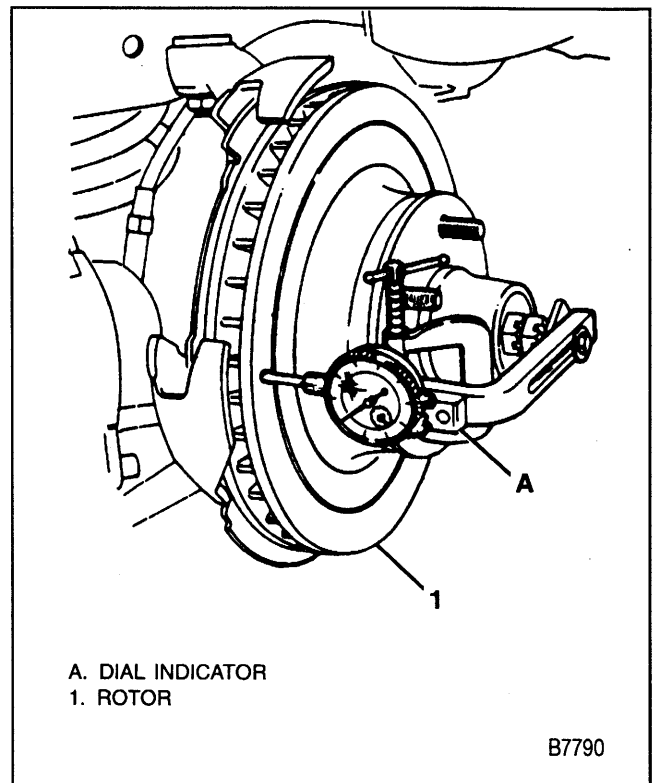
In addition to these tolerances, the surface finish must be held to a specified range of 60 Ra roughness or less. The control of the braking surface finish is necessary to avoid problems of hard pedal apply, excessive brake fade, pulls, and erratic performance. In addition, control of the surface finish can improve lining life.

Light scoring of the rotor surfaces not exceeding 1.5 mm (0.06 in.) in depth is normal and not detrimental to brake operation.

THICKNESS VARIATION CHECK

Check thickness variation by measuring the rotor thickness at four or more points around the circumference of the rotor. Use a micrometer calibrated in ten-thousands of an inch. Make all measurements at the same distance in from the edge of the rotor.

A rotor that varies in thickness by more than 0.013 mm (0.0005 in.) can cause pedal pulsation and/or front end vibration during brake applications. A rotor that does not meet these specifications should be refinished or replaced.


Figure 3—Inspecting for Lateral Runout

LATERAL RUNOUT CHECK

The best way to check lateral runout is with the wheels still installed on the vehicle. This gives a much more accurate reading of the total indicated runout (T.I.R.) under real braking conditions. If equipment is not available to perform the check with the wheels installed, the next best reading can be made with the wheels removed but the caliper still installed.

1. Clean rotor surface.

Important

- If the wheel must be removed, reinstall the wheel nuts to retain the rotor. Tighten the wheel nuts to the correct torque specification following the wheel nut tightening sequence shown in SECTION 3E.
2. Fasten a dial indicator to the steering knuckle so the indicator button contacts the rotor surface about 13 mm (0.5 in.) from the outer edge (figure 3).
 3. Set the dial indicator to zero.
 4. Turn the wheel one complete revolution and observe the runout indicated on the dial.
 5. The total indicated runout (T.I.R.) must not exceed 0.08 mm (0.003 in.).
 6. If lateral runout is not within specifications, refinish or replace the rotor as necessary.

In some cases, excessive lateral runout can be improved by indexing the rotor on the hub one or two bolt positions from the original position. If lateral runout cannot be corrected by indexing the rotor, check the hub and bearing assembly for excessive lateral runout or looseness. If the hub and bearing assembly lateral runout exceeds 0.040 mm (0.0015 in.), repair or replace the hub and bearing assembly.

5B1-4 FRONT DISC BRAKES

NOTICE: Any time the brake rotor has been separated from the wheel bearing flange, clean any rust or foreign material from the mating surfaces of the wheel bearing flange and rotor. Failure to do so can result in increased lateral runout and brake pulsation.

CALIPER INSPECTION

With the caliper removed, inspect the inside of the caliper assembly for signs of fluid leakage. If any is found, overhaul the caliper as outlined in "Unit Repair."

Inspect the mounting bolts and sleeves for corrosion. Replace any corroded bolts and sleeves. Do not attempt to polish away the corrosion.

ON-VEHICLE SERVICE

CALIPER

DELCO

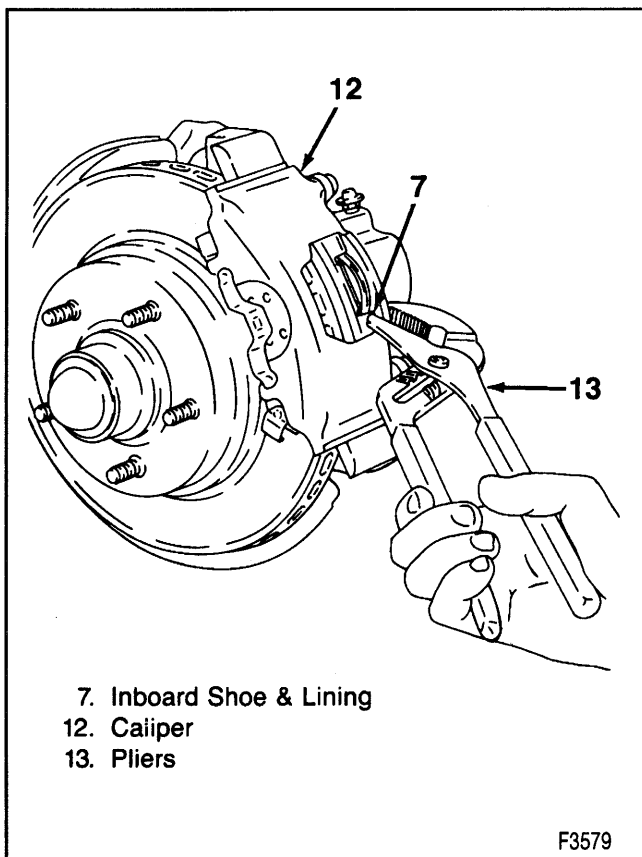


Remove or Disconnect (Figures 4 through 9)

1. Two-thirds of the brake fluid from master cylinder.
2. Raise vehicle and support with safety stands.
3. Tire and wheel. Refer to SECTION 3E.
 - On models with composite rotors, reinstall two lug nuts to retain rotor.

CAUTION: Refer to "Caution" on page 5B1-1.

4. Compress piston using adjustable pliers over inboard lining (7) tab and caliper housing flange (12).
5. Brake hose from caliper by removing inlet fitting bolt (14).
6. Mounting bolts (2) (figure 5).
7. Bolt boots (1).
8. Caliper (12).



7. Inboard Shoe & Lining
12. Caliper
13. Pliers

F3579

Figure 4—Compressing the Piston



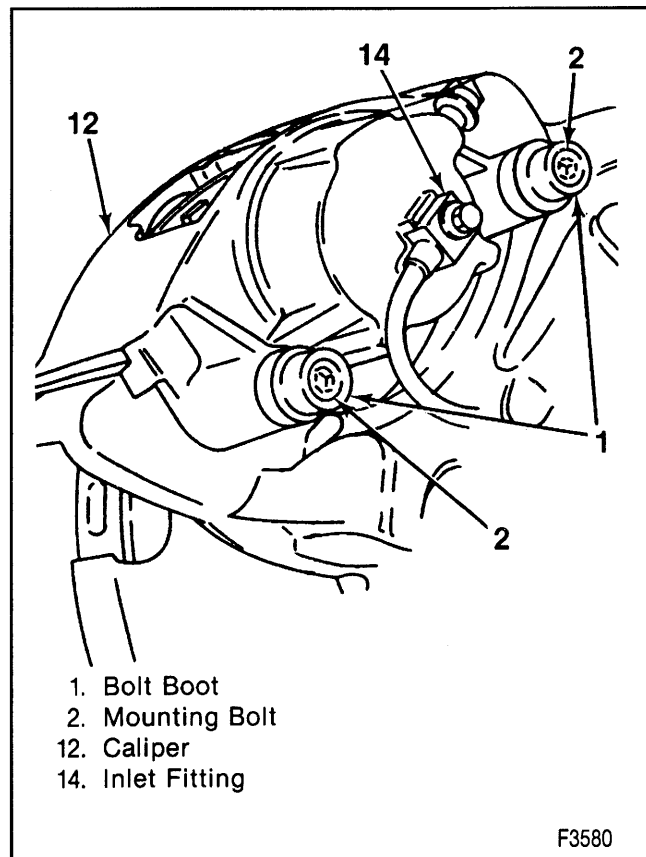
Inspect

- Mounting bolt and sleeve assemblies for corrosion. Replace if any is found.
 - Do not attempt to polish away corrosion.
- Bolt boots for nicks, cuts, or corrosion. Replace if any are found.



Important

- Clean the caliper assembly and install a new brake hardware kit any time it is removed from rotor.



1. Bolt Boot
2. Mounting Bolt
12. Caliper
14. Inlet Fitting

F3580

Figure 5—Caliper Attachment (Delco)

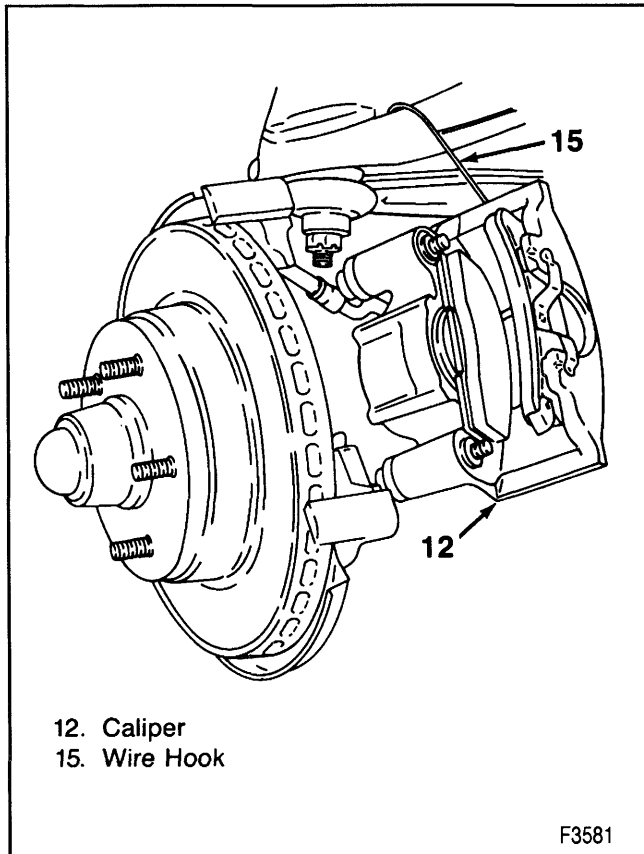


Figure 6—Suspending the Caliper

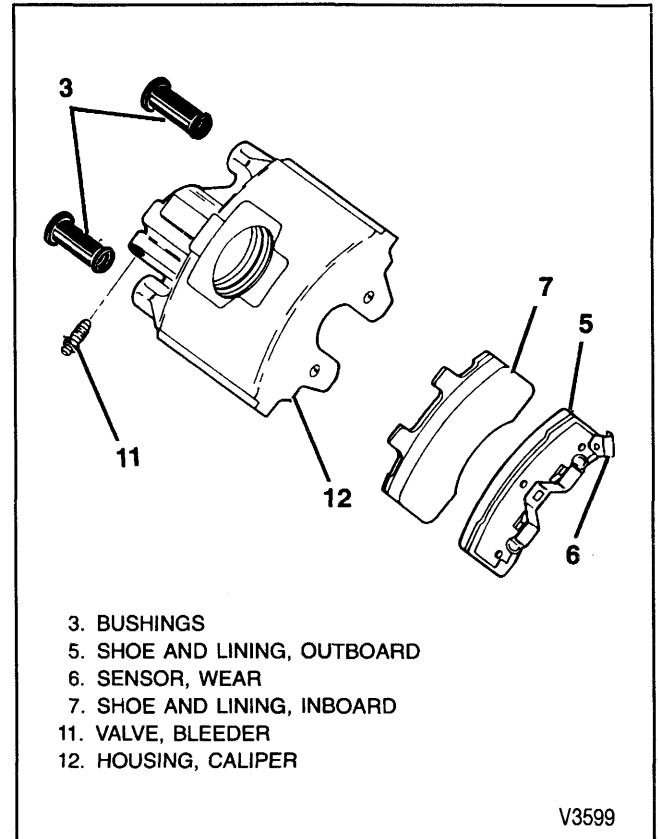


Figure 8—Delco Shoe and Lining Assembly (3486)

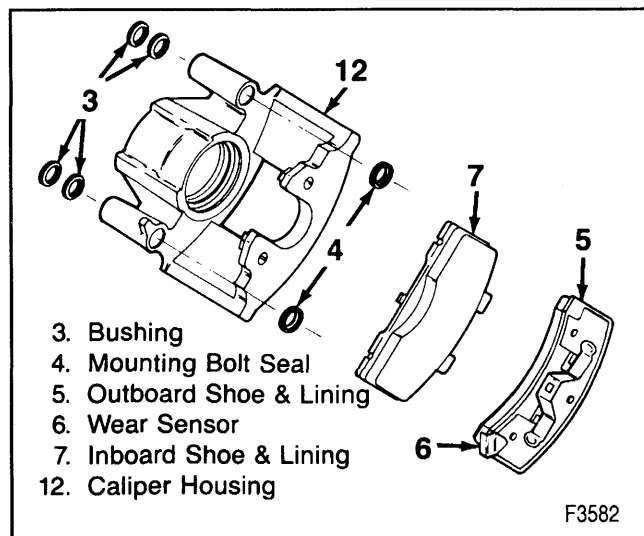


Figure 7—Delco Shoe and Lining Assembly (3400)

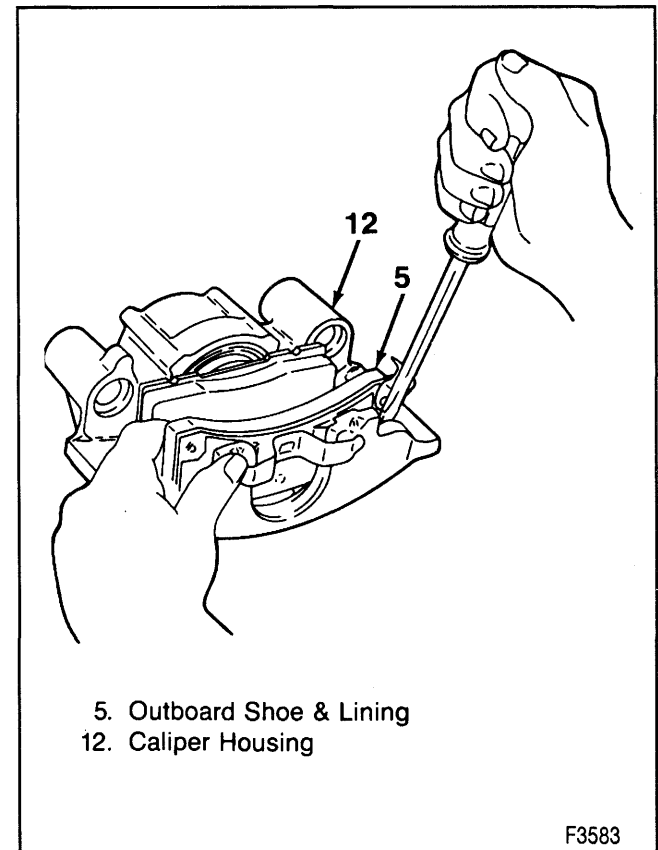


Figure 9—Removing the Outboard Shoe and Lining

5B1-6 FRONT DISC BRAKES



Install or Connect (Figures 5 through 14)

NOTICE: For steps 5 and 6, refer to "Notice" on page 5B1-1.

1. New bushings (3) and bolt seals (4).
2. Lubricate bushings (3) and mounting bolt seals (4) with Delco Silicone Lube (GM P/N 18010909) or equivalent (figure 12 or 13).
3. New bolt boots (1).
4. Caliper (12).
 - Fill both housing cavities between bushings (3) with Delco Silicone Lube (GM P/N 18010909) or equivalent (figure 12 or 13).
5. Mounting bolt and sleeve assemblies (2).



Tighten

- Bolt (2) to 51 N·m (38 lbs. ft.).
 - The bolt boots (1) must remain secure after tightening bolts.
- 6. Brake hose to caliper.



Tighten

- Brake hose bolt to 45 N·m (33 lbs. ft.)



Measure (Figure 14)

- Clearance between caliper (12) and bracket stops (16).
- If necessary, remove caliper and file the ends of bracket (16) to obtain 0.13 to 0.30 mm (0.005 to 0.012 in.) total clearance. (Measure the clearances individually and add them together).

7. Tire and wheel. Refer to SECTION 3E.



Important

- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal is obtained. Check the fluid level in the master cylinder after pumping the brakes.

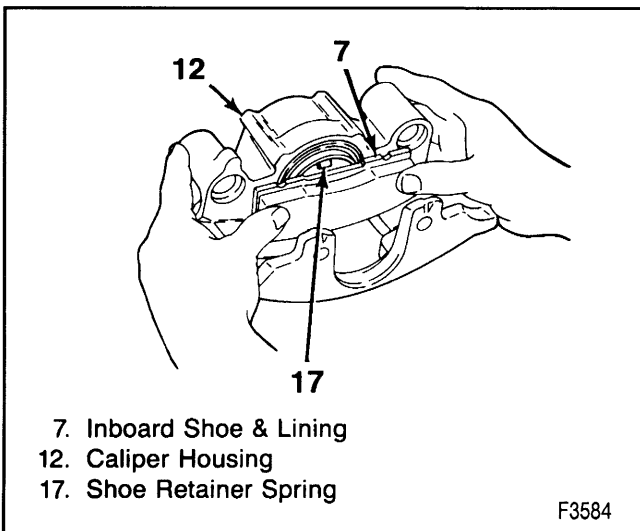


Figure 10—Installing the Inboard Lining

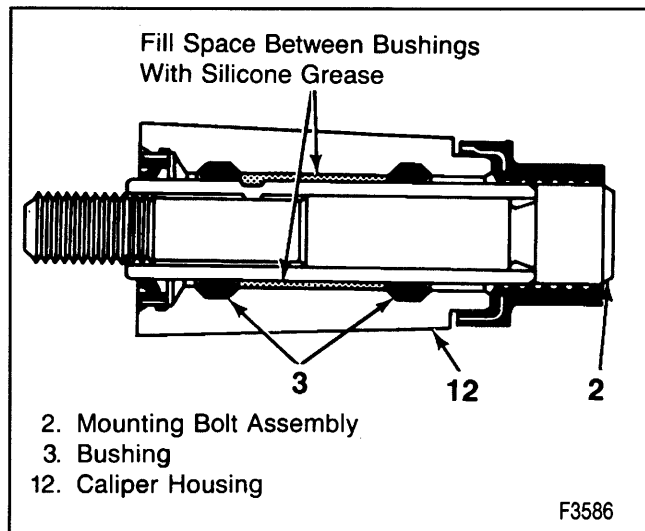


Figure 12—Mounting Bolt Lubrication (Delco 3400)

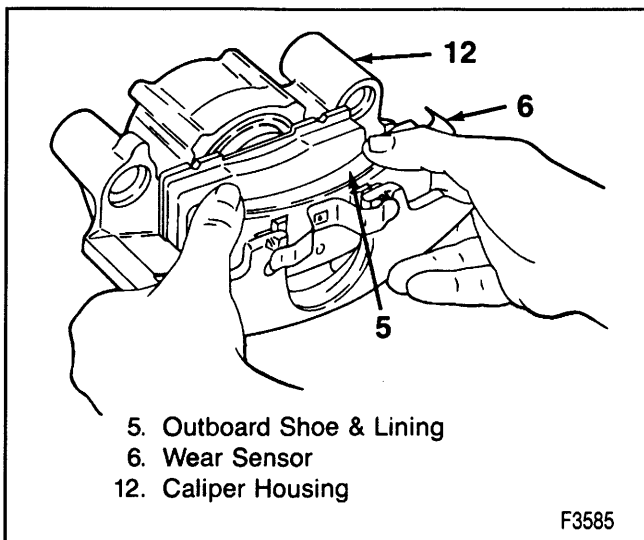


Figure 11—Installing the Outboard Lining

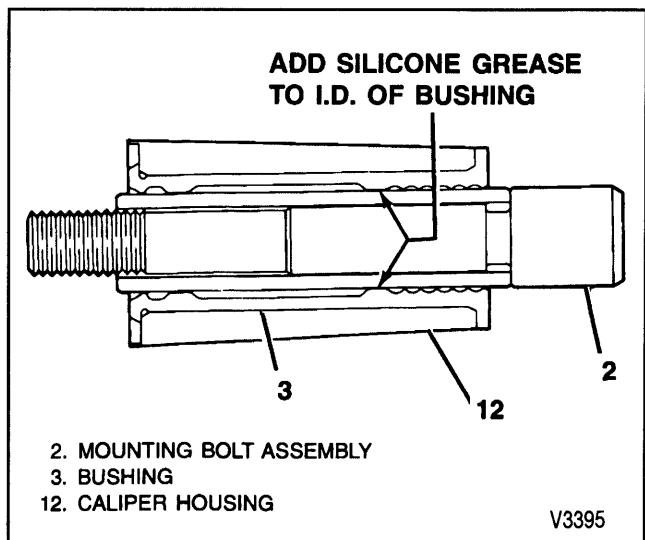


Figure 13—Mounting Bolt Lubrication (Delco 3486)

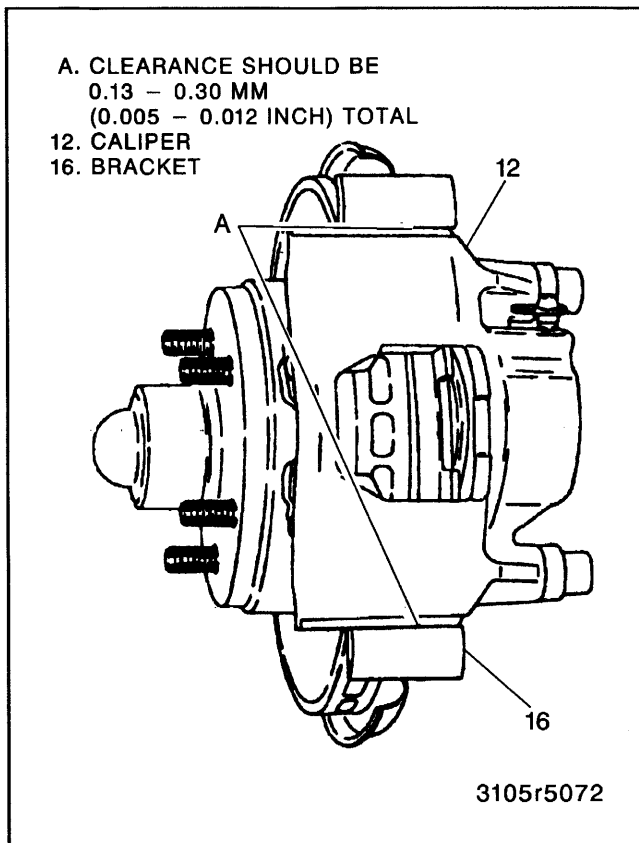


Figure 14—Caliper to Bracket Clearance

BENDIX



Remove or Disconnect (Figures 15 through 19)

1. Two-thirds of the brake fluid from master cylinder.
2. Raise vehicle and support with safety stands.
3. Mark relationship of wheel to hub.
4. Tire and wheel. Refer to SECTION 3E.

CAUTION: Refer to “Caution” on page 5B1-1.

5. Position a C-clamp and tighten until piston bottoms in bore (figure 16).
6. C-clamp.
7. Brake hose.
8. Bolt (2).
9. Support key (3) and spring (4).

- Use a brass punch and a hammer to drive the support key out (figure 18).

10. Caliper assembly (1).



Inspect

- The inside of the caliper assembly for signs of fluid leakage. If any is found, refer to “Unit Repair.”



Clean

- Use a wire brush to remove any corrosion from the machined surfaces of the anchor plate and caliper.

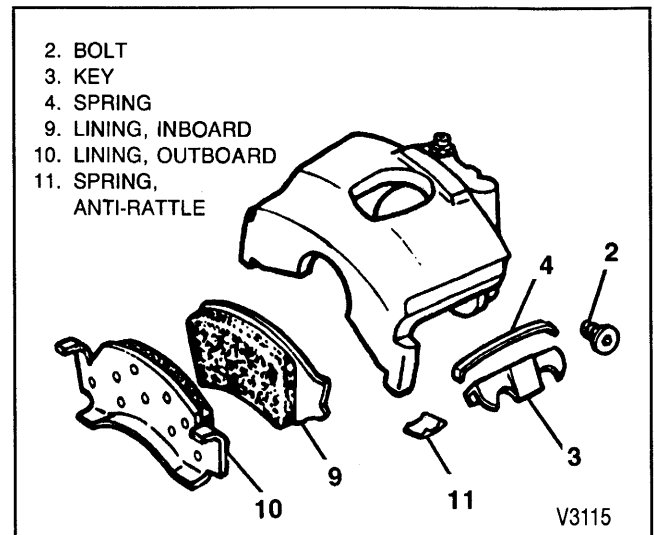


Figure 15—Bendix Shoe and Lining Assembly

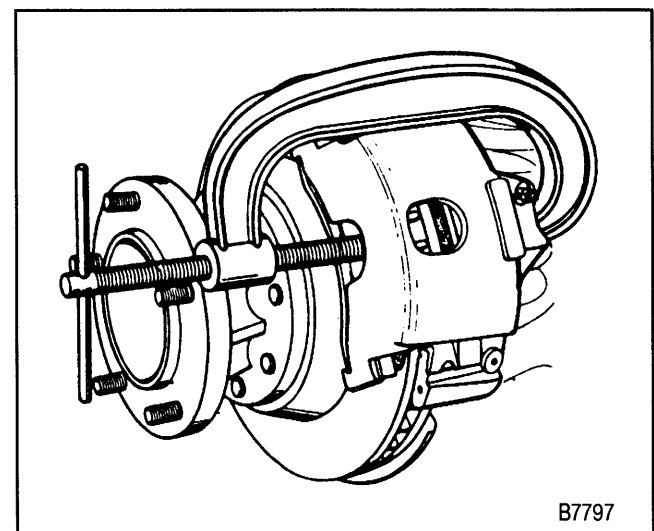


Figure 16—Compressing the Caliper Piston

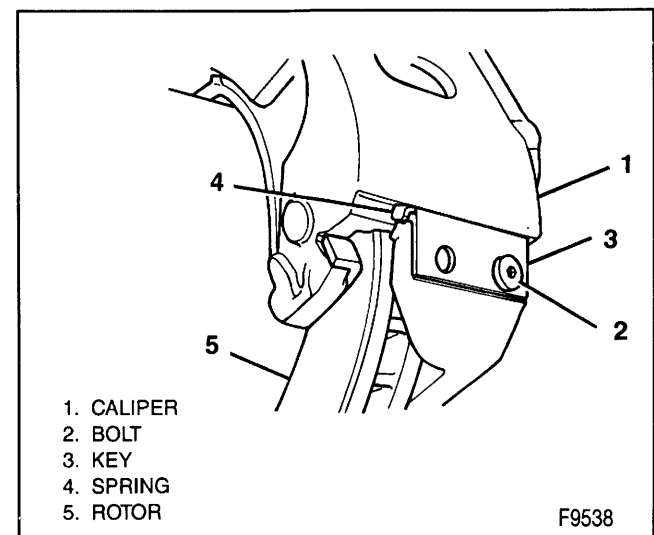


Figure 17—Caliper Mounting

5B1-8 FRONT DISC BRAKES

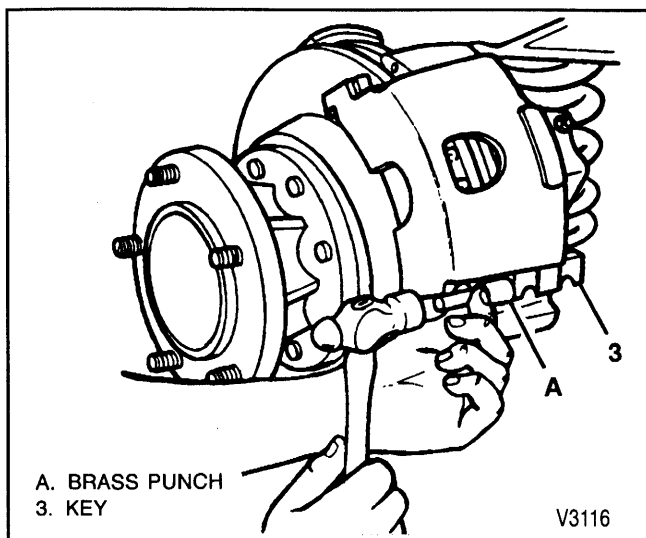


Figure 18—Removing the Caliper Support Key

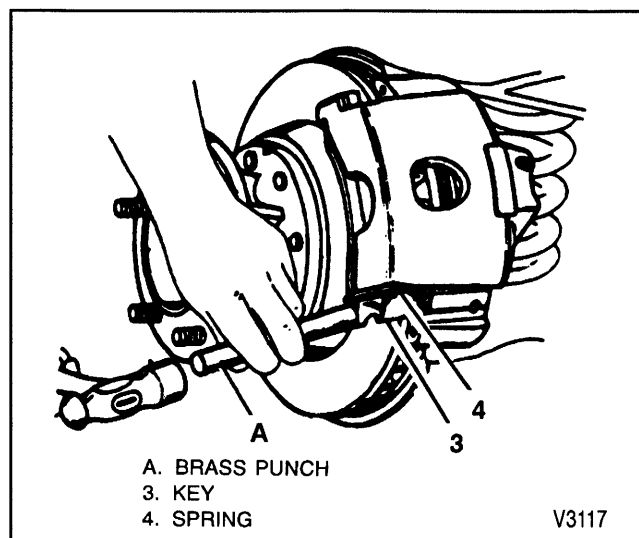


Figure 20—Installing the Caliper Support Key

NOTICE: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

3. Spring (4) and support key (3).
 - Use a brass punch and hammer to drive the support key in place (figure 20).
4. Bolt (2).
 - The boss on the bolt must fit into the circular cutout in the key.



Tighten

- Bolt (2) to 20 N.m (15 lbs. ft.).

5. Brake hose.



Tighten

- Brake hose bolt to 45 N.m (33 lbs. ft.)

6. Bleed brake system. Refer to SECTION 5.
7. Tire and wheel. Refer to SECTION 3E.
8. Lower the vehicle.



Important

- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal is obtained. Check the brake fluid level in the master cylinder after pumping the brakes.

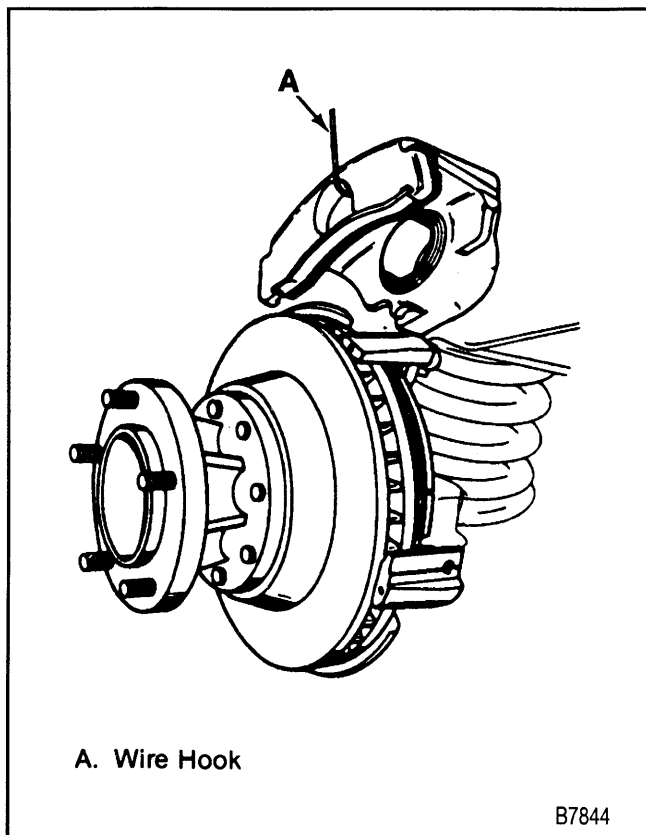


Figure 19—Suspending the Caliper



Install or Connect (Figures 15 through 20)

NOTICE: For steps 4 and 5, refer to "Notice" on page 5B1-1.

1. Lubricate caliper and anchor plate sliding surfaces with Delco Silicone Lube (GM P/N 18010909) or equivalent.
2. Caliper assembly (1).

LININGS

GM replacement brake lining material is recommended for all vehicles to maintain the balance between front and rear brake performance. GM replacement brake parts have been carefully selected to provide the proper brake balance for the purposes of stopping distance and control over the full range of operating conditions. Installation of front or rear lining material with performance different from that of GM replacement parts recommended for this vehicle can change the intended brake balance of this vehicle.

DELCO



Remove or Disconnect (Figures 6 through 14)

1. Caliper. Refer to "Caliper."
 - Suspend the caliper with a wire hook (figure 6).
2. Outboard shoe and lining (5) (figure 9).
 - Use a screwdriver to disengage the buttons on the pad from the holes in the caliper housing.
3. Inboard shoe and lining (7).
4. Bolt boots (1).
5. Mounting bolt seals (4).
6. Bushings (3).



Inspect

- Mounting bolts, key, spring, and sleeves for corrosion. Replace if any is found.
 - Do not attempt to polish away corrosion.
- Bolt boots for nicks, cuts, or corrosion. Replace if any are found.



Important

- Clean the caliper assembly and install a new brake hardware kit any time it is removed from the rotor.



Install or Connect (Figures 10 through 12)

1. Lubricate bushings (3) and mounting bolt seals (4) with Delco Silicone Lube (GM P/N 18010909) or equivalent.
2. New bushings (3) and bolt seals (4) (if used).
3. New bolt boots (1).
4. Inboard lining (7).
 - Snap retainer spring (17) into piston (9) (figure 10).
 - The pad retainer spring (17) is already staked to inboard shoe.
 - The pad must lay flat against piston.
5. Outboard lining (5) with wear indicator (6) at leading edge of pad during forward wheel rotation (figure 11).
 - The back of pad must lay flat against caliper.
6. Caliper (12). Refer to "Caliper."



Important

- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal is obtained. Check the fluid level in the master cylinder after pumping the brakes.

BENDIX



Remove or Disconnect (Figure 15 and 19)

1. Caliper (1). Refer to "Caliper."
 - Suspend the caliper (figure 19).

NOTICE: Do not allow calipers to hang from the flexible hoses. Doing so can damage the hoses.

2. Inboard lining (9).
3. Anti-rattle spring (11).
4. Outboard lining (10).



Inspect

- The inside of the caliper assembly for signs of fluid leakage. If any is found, refer to "Unit Repair."



Clean

- Use a wire brush to remove any corrosion from the machined surfaces of the steering knuckle and caliper.



Install or Connect (Figure 15)

1. Lubricate the caliper and steering knuckle (or support) sliding surfaces and spring with Delco Silicone Lube (GM P/N 18010909) or equivalent.
2. Inboard lining (9) and anti-rattle spring (11).
3. Outboard lining (10).
4. Caliper assembly (1). Refer to "Caliper."



Important

- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal is obtained. Check the brake fluid level in the master cylinder after pumping the brakes.

BURNISHING LININGS AND ROTORS

After replacing brake linings and/or refinishing rotors, the new braking surface should be broken in, or "burnished." To do this, make 20 stops from 30 mph using medium to firm brake pedal pressure. During this procedure, use care to avoid overheating the brakes.

CALIPER AND ANCHOR PLATE WEAR ADJUSTMENTS

Bendix calipers have oversize replacement keys available to compensate for wear at the caliper to anchor plate contact points. The keys are identified by marks as indicated in figure 21. If wear is excessive, a rattle sound can be heard from the front brake area. Use the following procedure to measure and correct this condition.

Refer to figure 21.

1. Remove caliper. Refer to "Caliper."
2. Clean surfaces A, B, C, and D with a wire brush.
3. Smooth any deep nicks and/or gouges with a file.
4. Measure caliper contact surface for wear.
 - A. Lay a straight edge across caliper surfaces "C" and "D."
 - B. Measure the maximum depth of any wear on these surfaces using feeler gauges.
 - C. Replace calipers worn to a depth of 0.050 inch or more.
5. Measure caliper to anchor plate wear.
 - A. Install caliper back in the knuckle.
 - B. Install a new standard size key without the spring.

5B1-10 FRONT DISC BRAKES

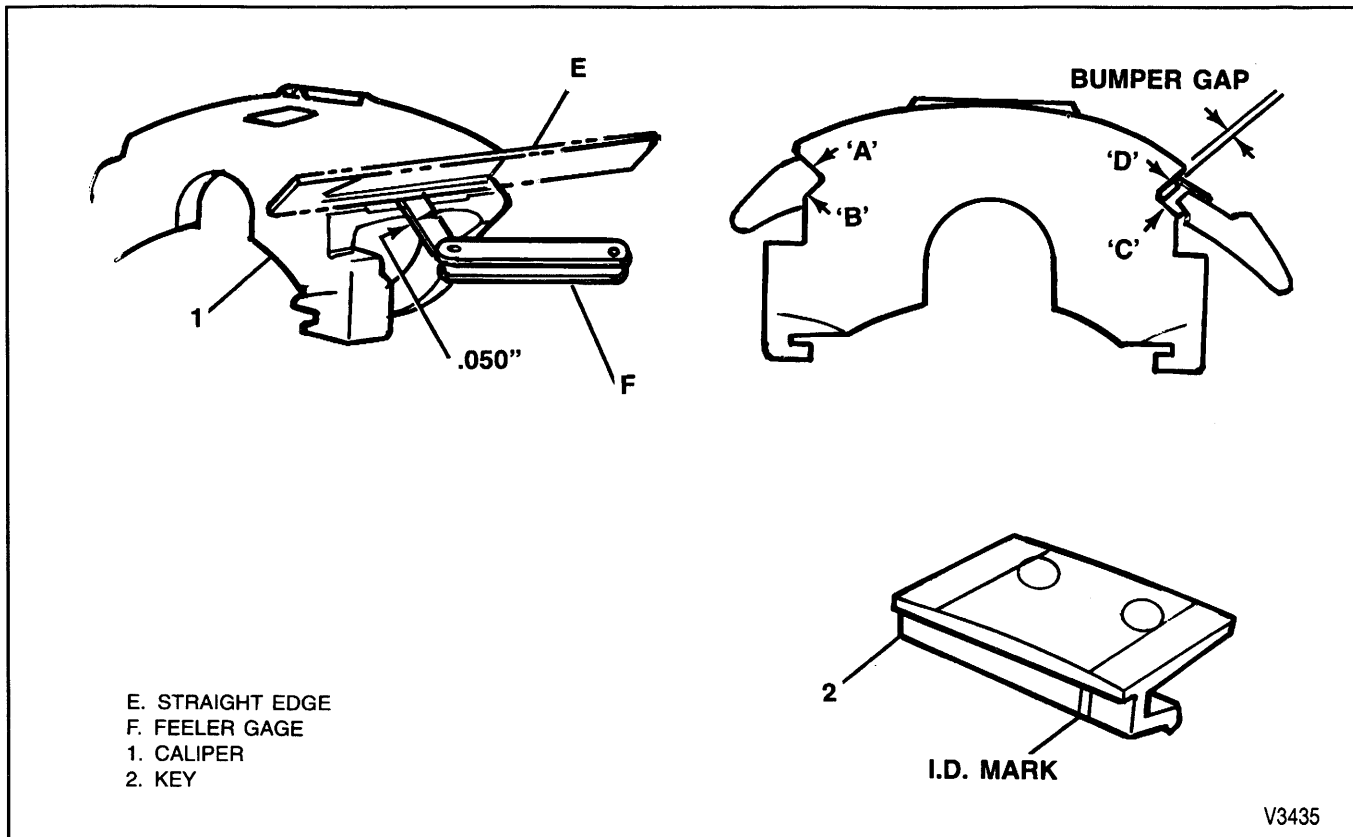


Figure 21—Bendix Caliper Wear Adjustment

- C. Install the key retention bolt.
- D. Insert a screw driver into the center of key bumper gap.
- E. Pry firmly to ensure that caliper is seated at surfaces "A," "B," and "C."
- F. Measure the bumper gap with largest feeler gauge(s) that will fit into the gap its full length.
- G. Select a replacement key according to the table in "Specifications."
6. Install caliper. Refer to "Caliper."

ANCHOR PLATE

For anchor plate on-vehicle service information, refer to SECTION 3C.

ROTOR

For rotor on-vehicle service information, refer to SECTION 3C.

UNIT REPAIR

REFINISHING BRAKE ROTORS

You do not need to refinish brake rotors when doing routine brake maintenance such as replacing worn brake shoe and lining assemblies. Refinish rotors only under the following circumstances:

1. There is a complaint of brake pulsation.
2. There are heat spots or excessive scoring.

Brake rotors have a minimum thickness dimension cast into them. This dimension is the minimum wear dimension and not a refinish dimension. Do not use a brake rotor that will not meet the dimensions shown in the specifications chart after refinishing. A rotor that is too thin will not have the proper heat transfer capabilities. Replace it with a new rotor. Refinishing composite rotors requires using rotor adapter tool J 39441 as a holding fixture for the brake lathe (figure 22).

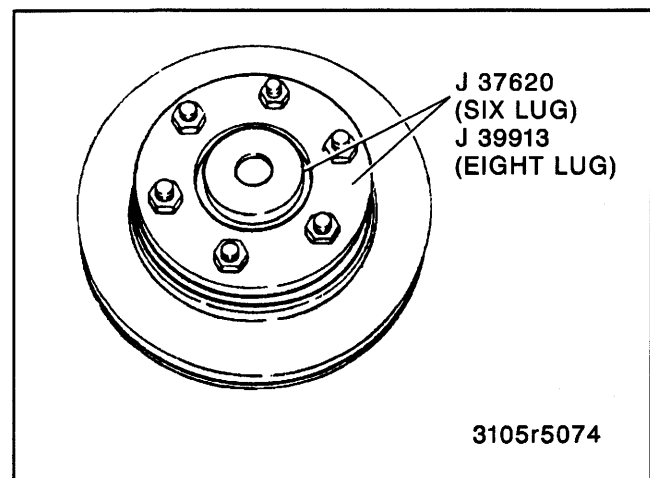


Figure 22—Rotor Adapter Installed on the Rotor

Accurate control of rotor tolerances is necessary for the proper performance of disc brakes. Machining should be done only with precision equipment. Service the machining equipment on a regular basis following the manufacturer's recommended maintenance procedures.

When refinishing rotors, make sure the attaching adapters, tool holders, vibration dampeners, and tool bits are in good condition. Always use sharp cutting tools or bits and use only replacement cutting bits recommended by the equipment manufacturer. Dull or worn tools leave a poor surface finish that will affect initial brake performance. Always use vibration dampening attachments when refinishing braking surfaces. These attachments eliminate tool chatter to allow for a better surface finish. Make sure these adapters are clean and free of nicks.

Following are two recommended procedures that achieve adequate results using two different off vehicle drum/disc brake lathes. If any other lathe is used, follow that manufacturer's instructions and recommendations.

AMMCO BRAKE LATHE

	Rough Cut	Finish Cut
Spindle Speed	150 rpm	150 rpm
Depth of Cut (per side)	0.127 mm (0.005 in.)	0.051 mm (0.002 in.)
Total Cross Feed (per revolution)	0.152-0.254 mm (0.006-0.010 in.)	0.051 mm max. (0.002 in.)
Vibration Damp.	Yes	Yes
Swirl Pattern - 120 Grit	No	Yes

T2914

ACCU. TURN BRAKE LATHE, GM DEALER EQUIPMENT (One Cut Refinishing Procedure)

Spindle Speed	150 rpm
Tool Cross Feed (per rev.)	0.076 mm (0.003 in.)
Tool Bit Nose Radius	1/64
Vibration Damper	Yes
Swirl Pattern - 120 Grit	Yes

T2915

Locate the deepest score and turn the rotor micrometer knobs until the tool bit bottoms out at the deepest point of the score. Zero the scale and back out the tool bits. Advance the cutter hand-wheel until the bits have cleared the inner edge of the rotor face. Adjust the micrometer knobs for approximately 0.0127 mm (0.005 in.) more than the first reading. This will ensure clearing the rotor in one cut.

It is very important that you make the rotor surface non-directional by dressing the rotor surfaces with a sanding disc power tool such as Ammco 8350 Safe

Swirl Disc Rotor Grinder using 120 grit aluminum oxide sandpaper. Sand each rotor surface using moderate pressure for a minimum of 60 seconds. An alternate method is to use a sanding block with 150 grit aluminum oxide sandpaper. With the rotor turning at approximately 150 rpm, sand each rotor surface using moderate pressure for a minimum of 60 seconds. After sanding the rotor, clean each surface with denatured alcohol or a suitable brake cleaner.

The finished rotor surface should be as close to that of a new rotor as possible. Failure to obtain the best possible rotor finish can affect initial braking performance.

CALIPER

DELCO

Remove or Disconnect (Figures 23 through 28)

1. Fluid from the caliper.
2. Pad the interior of the caliper with clean shop towels.

CAUTION: Do not place your fingers in front of the piston in an attempt to catch or protect it when applying compressed air. This could result in serious injury.

NOTICE: Use just enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.

3. Piston (9).
 - Direct compressed air into caliper fluid inlet (figure 25).
 - Use just enough air pressure to ease piston out of bore.
4. Boot (8) (figure 26).
 - Use care not to scratch housing bore.
5. Piston seal (10).
 - Do not use any type of metal tool.
6. Bleeder valve (11).



Clean

- Bleeder valve, caliper bore, caliper passages, and piston with denatured alcohol. Use dry, filtered, compressed air to dry parts and blow out passages.



Inspect

- Piston for scoring, nicks, corrosion, wear, and damaged chrome plating. Replace piston if any of these are found.
- Caliper bore and seal groove for scoring, nicks, corrosion, or wear. Use crocus cloth to polish out any light corrosion. Replace caliper if corrosion cannot be removed.

5B1-12 FRONT DISC BRAKES

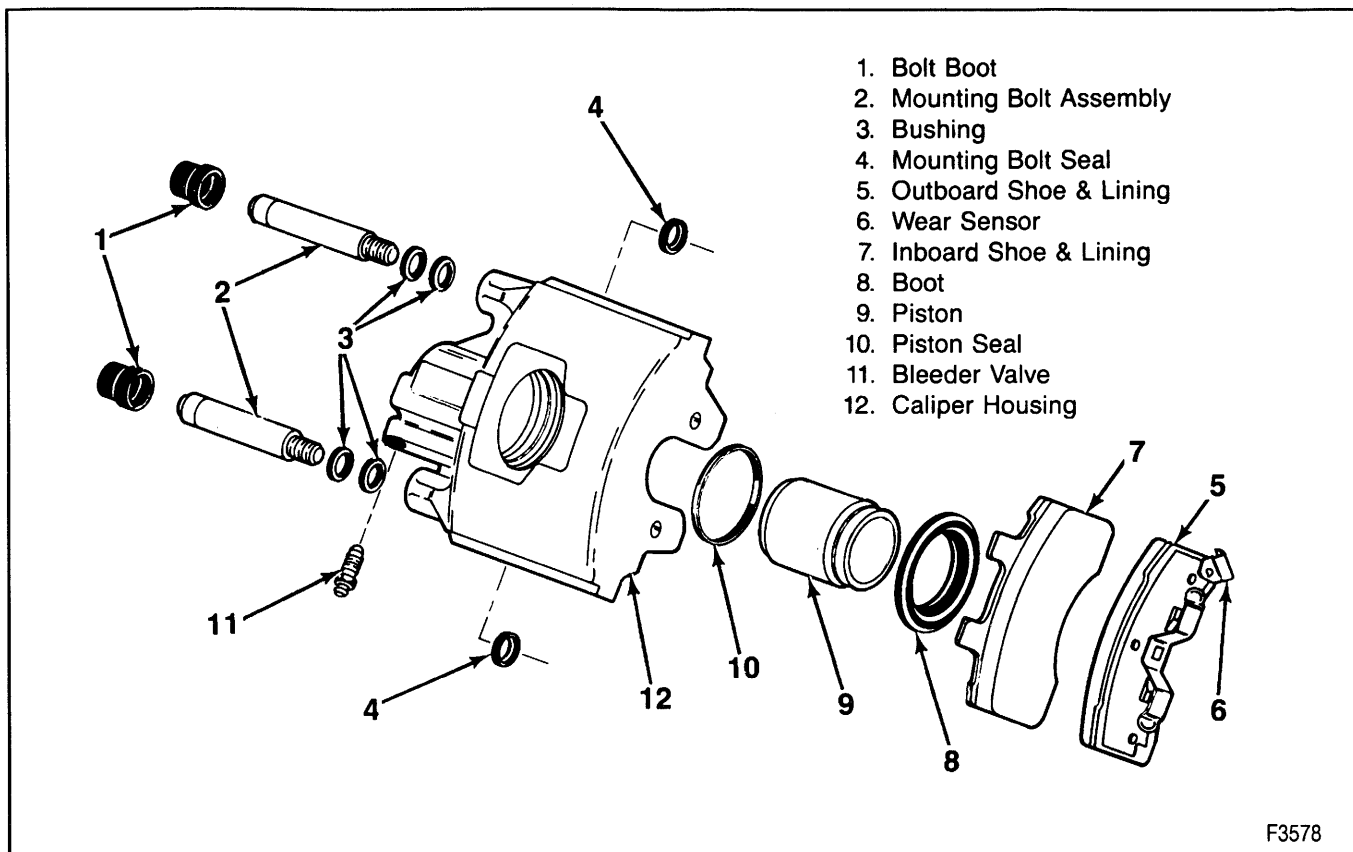


Figure 23—Caliper Components (Delco 3400)

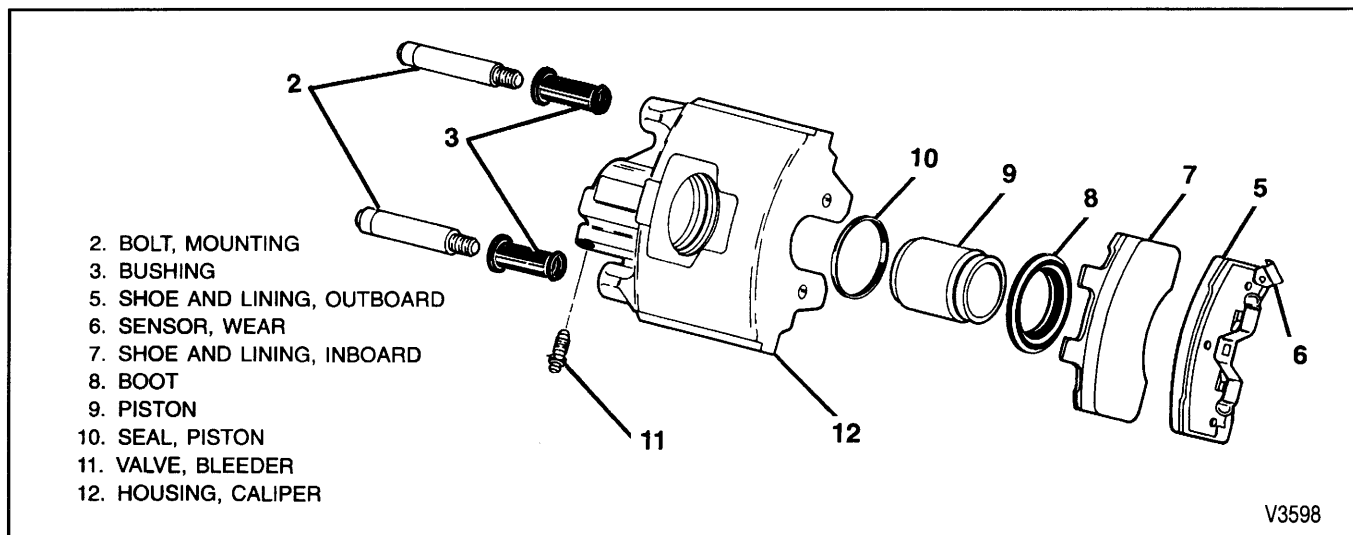


Figure 24—Caliper Components (Delco 3486)

Install or Connect (Figures 23 through 28)

Tools Required:

- J 36474—75 mm Boot Seal Installer or
- J 36475—80 mm Boot Seal Installer or
- J 38453—86 mm Boot Seal Installer

1. Lubricate new piston seal, caliper bore, and piston with clean brake fluid.
2. Piston seal (10).

- Use care not to twist the seal.

3. Boot (8) on piston (9) (figure 27).
4. Piston (9) and boot into caliper bore.

- A. Push piston to the bottom of bore.
- B. Seat boot in housing using J 36474, J 36475, or J 38453 (figure 27).

NOTICE: Refer to "Notice" on page 5B1-1.

5. Bleeder valve (11).

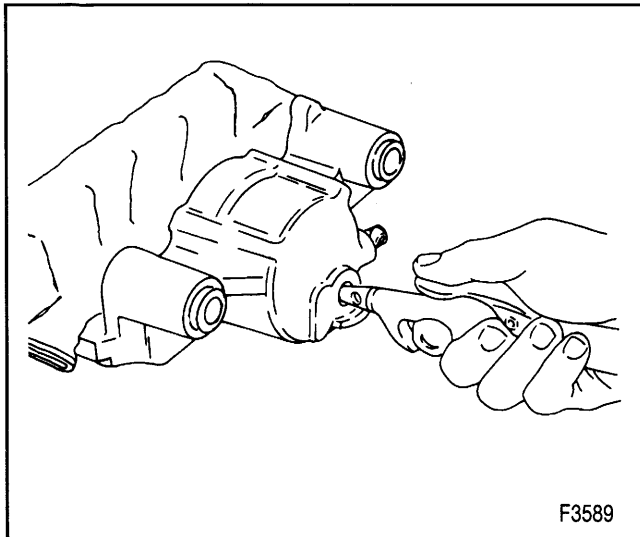


Figure 25—Removing the Piston

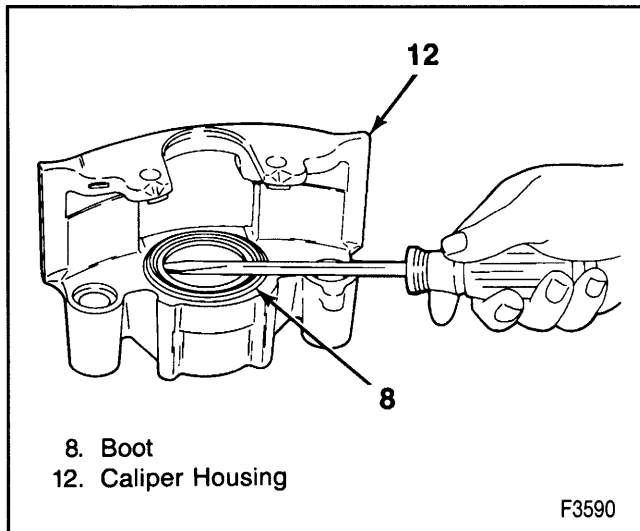


Figure 26—Removing the Boot



Tighten

- Bleeder (11) to 13 N.m (115 lbs. in.).

BENDIX



Remove or Disconnect (Figures 29, 30, and 31)

1. Fluid from caliper.
2. Pad interior of caliper with clean shop towels.

CAUTION: Do not place your fingers in front of the piston in an attempt to catch or protect it when applying compressed air. This could result in serious injury.

NOTICE: Use just enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.

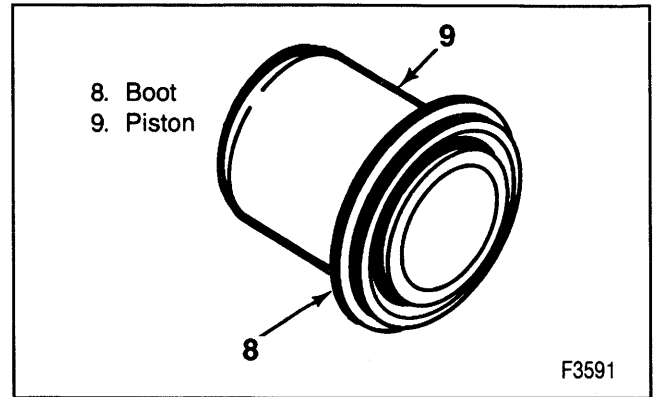


Figure 27—Installing the Boot on the Piston

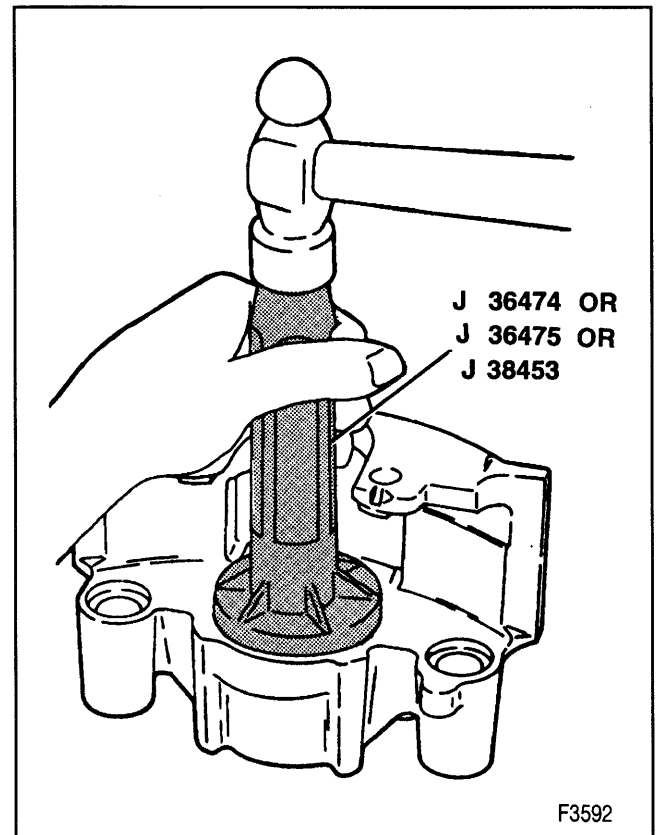


Figure 28—Seating the Boot in the Housing

3. Piston (22).

- Direct compressed air into caliper fluid inlet (figure 30).

4. Boot (23) (figure 31).
5. Piston seal (21).

- Do not use any type of metal tool.

6. Bleeder valve (20).



Clean

- Bleeder valve, caliper bore, caliper passages, and piston with denatured alcohol. Use dry, filtered, compressed air to dry parts and blow out passages.

5B1-14 FRONT DISC BRAKES

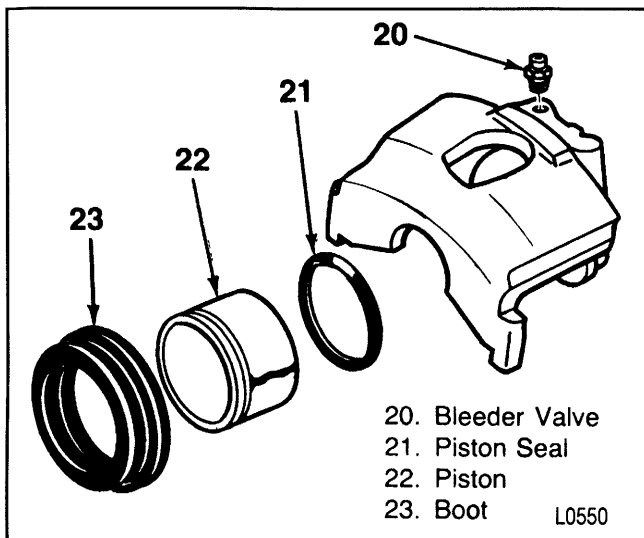


Figure 29—Caliper Components (Bendix)

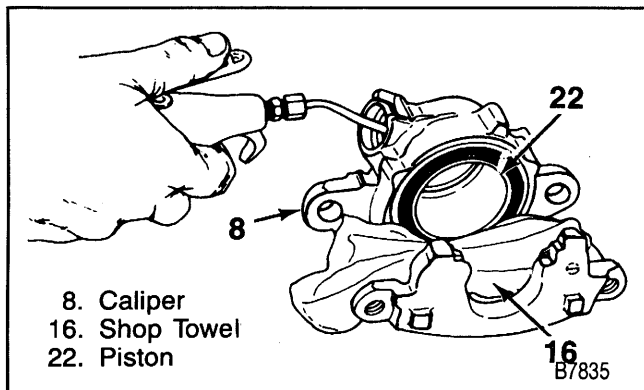


Figure 30—Removing the Piston



Inspect

- Piston for scoring, corrosion, and damage to the chrome plating. Replace it if any of these conditions are found.
- Caliper bore for scoring, pitting, or corrosion. Use crocus cloth to polish out any light corrosion. Replace the caliper if the corrosion cannot be removed.



Install or Connect (Figure 29 and 32)

Tool Required:

J 24548 Piston Seal Installer

1. Lubricate new piston seal, caliper bore, piston, and seal lips on boot with clean brake fluid.
2. Piston seal (21).
 - Make sure seal is not twisted in caliper bore groove.
3. Boot (23) on J 24548.
 - A. Place large diameter of boot over tool first and carefully work smaller diameter onto tool.
 - B. Slide large diameter of boot off tool.
4. Large lip of boot in caliper bore groove.
 - Lip of boot must firmly seat in groove.

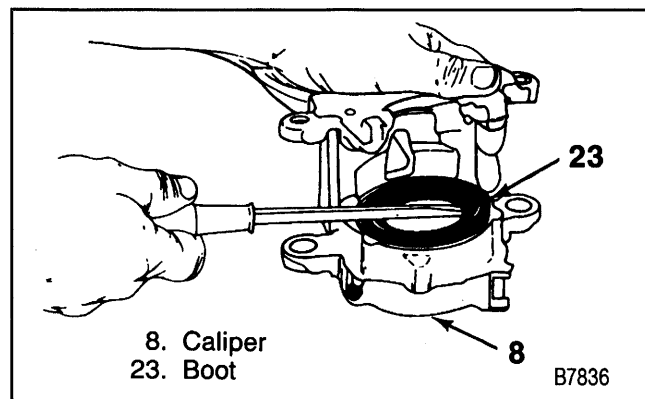


Figure 31—Removing the Boot

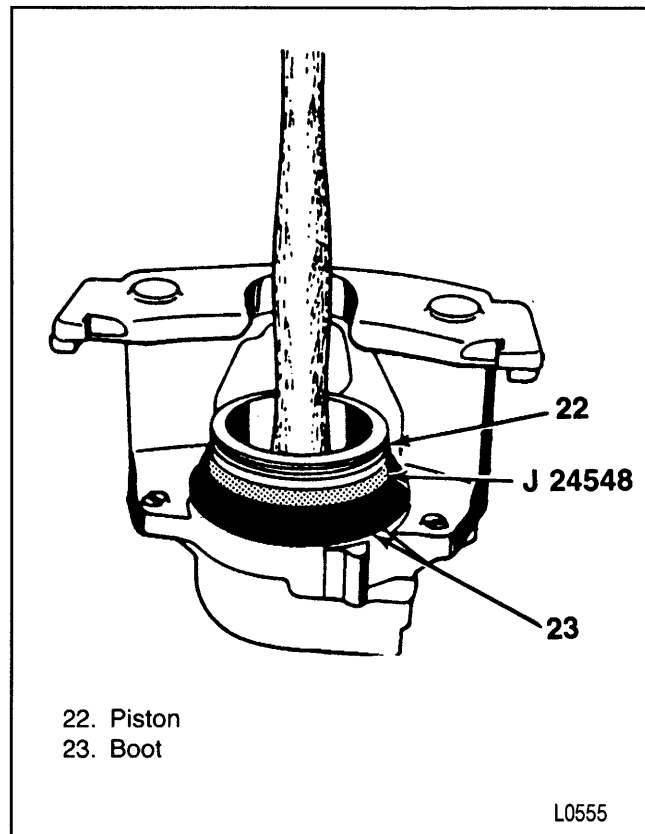


Figure 32—Installing the Piston

5. Piston (22) inside J 24548 (figure 32).
6. Piston halfway into bore.
 - A. Remove J 24548.
 - B. Make sure boot is firmly seated.

NOTICE: Refer to "Notice" on page 5B1-1.

7. Bleeder valve (20).



Tighten

- Bleeder valve to 7 N·m (62 lbs. in.).

SPECIFICATIONS

BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 2.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

ROTOR THICKNESS

ORIGINAL	THINNEST (REFINISHING)	REPLACEMENT (DISCARD)
31.75 mm (1.25 in.)	31.25 mm (1.23 in.)	30.86 mm (1.215 in.)
32 mm (1.26 in.)		
38.10 mm (1.50 in.)	37.59 mm (1.480 in.)	37.21 mm (1.465 in.)
39.11 mm (1.54 in.)		

T2697

BENDIX CALIPER REPLACEMENT KEY SPECIFICATIONS

Bumper Gap	Replacement Key	P/N
0.0 - 0.060	Std. Size - I	14023439
0.061 - 0.100	0.040 Oversize - II	14026793
0.101 - 0.140	0.080 Oversize - III	14026794
0.141 - 0.180	0.120 Oversize - IIII	14026795
0.181 - 0.220	0.160 Oversize - IIIII	14026796
0.221 -	Replace Caliper and Anchor Plate or Steering Knuckle	

T2961

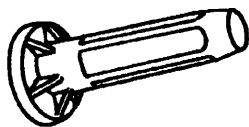
FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Ft. Lbs.	In. Lbs.
Bleeder Valve (Bendix)	7	—	62
Bleeder Valve (Delco)	13	—	115
Brake Hose to Caliper Bolt.....	45	33	—
Caliper Mounting Bolt (Delco).....	51	38	—
Splash Shield to Knuckle Bolt.....	26	19	—
Support Key Bolt (Bendix)	20	15	—

T2959

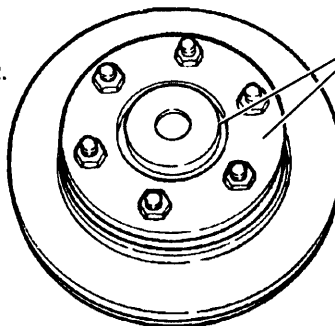
SPECIAL TOOLS

1.



J 36474 OR
J 36475 OR
J 38453

2.



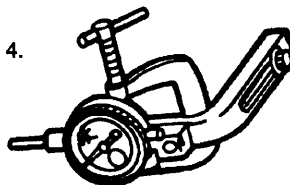
J 37620
(SIX LUG)
J 39913
(EIGHT LUG)

3.



J 24548

4.



J 24548

- 1. 75, 80, OR 86MM BOOT SEAL INSTALLER
- 2. BRAKE ROTOR TURNING TOOL
- 3. PISTON SEAL COMPRESSOR
- 4. DIAL INDICATOR

3105r5073

SECTION 5B2

REAR DISC BRAKES

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, by cleaning brake parts with a dry brush or with compressed air. Many earlier models or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: A new rotor must have the protective coating removed from the friction surfaces before being placed in service. Use Goodwrench Brake Parts Cleaner (GM P/N 12345754) or equivalent, and wipe the surface clean with clean cloths. Do not use gasoline, kerosene, or other oil base solvents that can leave an oily residue. This residue is damaging to brake linings and flammable.

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GENERAL DESCRIPTION

The disc brake assembly consists of a caliper assembly, rotor, linings, and anchor plate. Applying the brake pedal causes hydraulic pressure to move the piston. The piston then forces the inboard brake lining against the inboard braking surface of the rotor. Increasing the force against the rotor causes the caliper assembly to move inboard. The outer brake lining then contacts the outboard braking surface of the rotor. The force of the two brake linings provides the desired clamping action on the rotor.

Releasing the brake pedal relieves the pressure applied to the piston. The square cut seal on the piston returns to its normal position, allowing a running clearance between the brake linings and rotor.

Servicing Information

- Replace all components included in the repair kits.
- Lubricate the parts as specified.
- Do not use lubricated shop air on brake parts. Rubber component damage may result.
- After any hydraulic component has been removed or disconnected, if necessary, bleed all or part of the brake system.
- Replace shoes and linings in axle sets only.
- The torques specified are for dry, unlubricated fasteners.

- Perform service operations on a clean bench free from mineral oil and any other contaminants.
- Use extreme care when doing any work around the antilock components to prevent damage or misalignment.
- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal has been obtained. Check the brake fluid level in the master cylinder after pumping the brakes.

ROTOR

The rear disc brakes use a combination rotor and hub assembly. The rotor is integral with the rear hub. During operation, the rotor turns between the linings and basically free-wheels until the linings begin to apply a clamping action on it. The vented area between the rotor braking surfaces allows for efficient heat dissipation.

CALIPER

The rear disc brakes use a Bendix caliper. The caliper mounts to the anchor plate in a way that allows the caliper to move laterally against the rotor. The caliper is a one-piece casting with the inboard side containing a piston bore. A square-cut rubber seal fits in a groove in the piston bore to provide a hydraulic seal between the piston and caliper bore.

DIAGNOSIS

LINING INSPECTION

Inspect the brake linings every 6,000 miles and any time the wheels are removed (tire rotation, etc.). Check both ends of the outer lining by looking in at each end of the caliper (figure 1). These are the points where the highest rate of wear normally occurs. At the same time, check the thickness of the inner lining to make sure it has not worn prematurely. Some inboard shoe and linings have a thermal layer against the shoe, integrally molded with the lining. This extra layer should not be confused with uneven inboard-outboard lining wear. Look down through the inspection hole in the top of the caliper to view the inner lining. Replace shoe and lining assemblies whenever the thickness of any lining is worn to within 0.76 mm (0.030 in.) of the shoe. Replace riveted shoe and lining assemblies when the lining is worn to within 0.76 mm (0.030 in.) of any rivet head. Always replace disc brake shoe and lining assemblies as a complete axle set.

Check the flatness of the linings. Place the inboard and outboard lining surfaces together and check for a gap between the surfaces. This gap should not exceed 0.13 mm (0.005 inch) at the center of the lining surfaces. This applies to new or used shoe and lining assemblies.

The shoe and lining assemblies have a wear indicator that makes noise when the linings are worn and need replacement (figure 2).

ROTOR INSPECTION

ROTOR TOLERANCE AND SURFACE FINISH

During the manufacture of the brake rotor, tolerances of the braking surfaces for flatness, parallelism, and lateral runout are closely held. The maintenance of close tolerances on the shape of the braking surfaces is necessary to prevent brake roughness or pulsation.

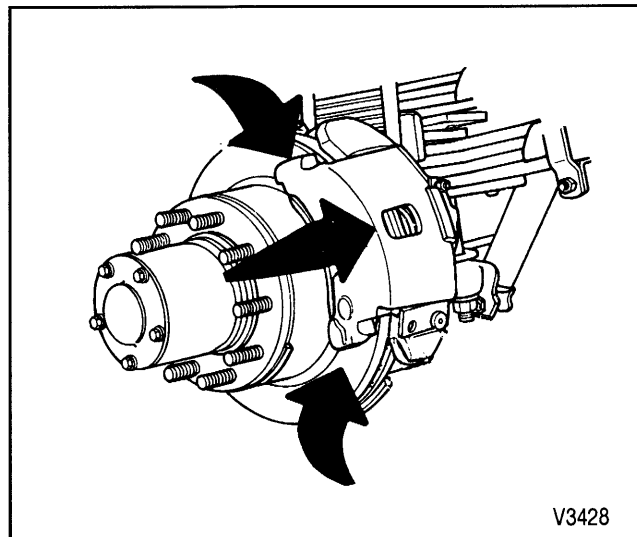


Figure 1—Lining Inspection Points

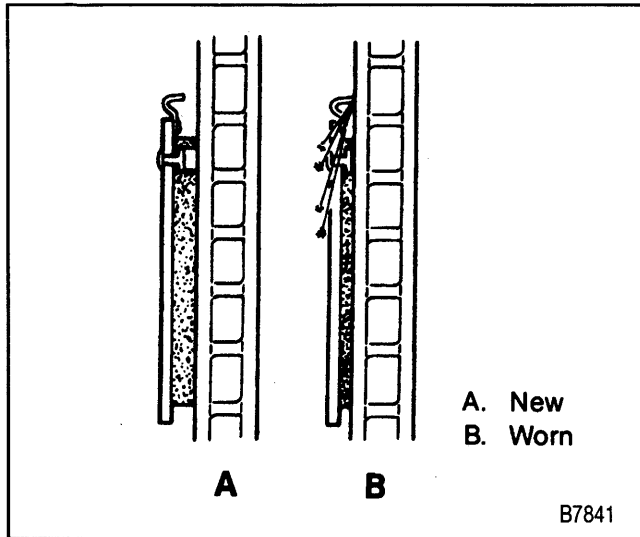


Figure 2—Wear Indicator

In addition to these tolerances, the surface finish must be held to a specified range of 60 Ra roughness or less. The control of the braking surface finish is necessary to avoid problems of hard pedal apply, excessive brake fade, pulls, and erratic performance. In addition, control of the surface finish can improve lining life.

Light scoring of the rotor surfaces not exceeding 1.5 mm (0.06 in.) in depth is normal and not detrimental to brake operation.

THICKNESS VARIATION CHECK

Check thickness variation by measuring the rotor thickness at four or more points around the circumference of the rotor. Use a micrometer calibrated in ten-thousands of an inch. Make all measurements at the same distance in from the edge of the rotor.

A rotor that varies in thickness by more than 0.013 mm (0.0005 in.) can cause pedal pulsation and/or front end vibration during brake applications. A rotor that does not meet these specifications should be refinished to specifications or replaced.

LATERAL RUNOUT CHECK

The best way to check lateral runout is with the wheels still installed on the vehicle. This gives a much more accurate reading of the total indicated runout (T.I.R.) under real braking conditions. If equipment is

not available to perform the check with the wheels installed, the next best reading can be made with the wheels removed but the caliper still installed.

1. Clean rotor surface.



Important

- If the wheel must be removed, reinstall the wheel nuts to retain the rotor. Tighten the wheel nuts to the correct torque specification following the wheel nut tightening sequence shown in SECTION 3E.
2. Fasten a dial indicator to the steering knuckle so the indicator button contacts the rotor surface about 13 mm (0.5 in.) from the outer edge.
 3. Set the dial indicator to zero.
 4. Turn the wheel one complete revolution and observe the runout indicated on the dial.
 5. The total indicated runout (T.I.R.) must not exceed 0.08 mm (0.003 in.).
 6. If lateral runout is not within specifications, refinish or replace the rotor as necessary.

In some cases, excessive lateral runout can be improved by indexing the rotor on the hub one or two bolt positions from the original position. If lateral runout cannot be corrected by indexing the rotor, check the hub and bearing assembly for excessive lateral runout or looseness. If the hub and bearing assembly lateral runout exceeds 0.040 mm (0.0015 in.), repair or replace the hub and bearing assembly.

NOTICE: Any time the brake rotor has been separated from the wheel bearing flange, clean any rust or foreign material from the mating surfaces of the wheel bearing flange and rotor. Failure to do so can result in increased lateral runout and brake pulsation.

CALIPER INSPECTION

With the caliper removed, inspect the inside of the caliper assembly for signs of fluid leakage. If any is found, overhaul the caliper as outlined in "Unit Repair."

Inspect the mounting bolts and sleeves for corrosion. Replace any corroded bolts and sleeves. Do not attempt to polish away the corrosion.

ON-VEHICLE SERVICE

CALIPER

Remove or Disconnect (Figures 3 and 4)

1. Two-thirds of the brake fluid from master cylinder.
2. Raise vehicle and support with safety stands.
3. Mark relationship of wheel to hub.
4. Tire and wheel. Refer to SECTION 3E.

CAUTION: Refer to "Caution" on page 5B1-1.

5. Position a C-clamp and tighten until piston bottoms in bore (figure 5).
6. C-clamp.
7. Brake hose.
8. Bolt (2).
9. Support key (3) and spring (4) (figure 6).
- Use a brass punch and a hammer to drive the support key out (figure 7).
10. Caliper assembly (1).

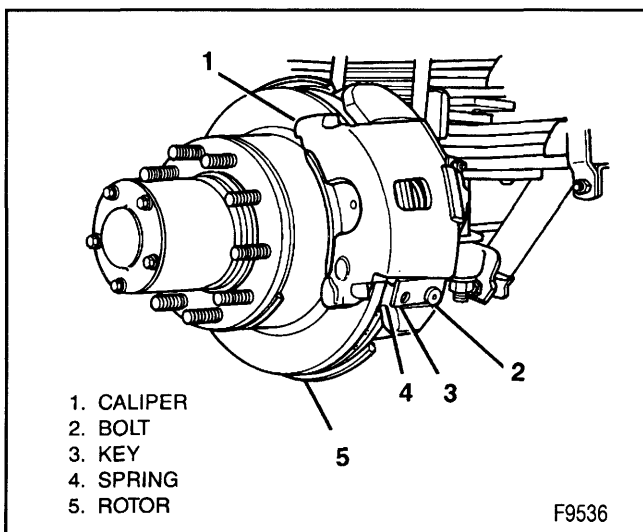


Figure 3—Disc Brake Assembly

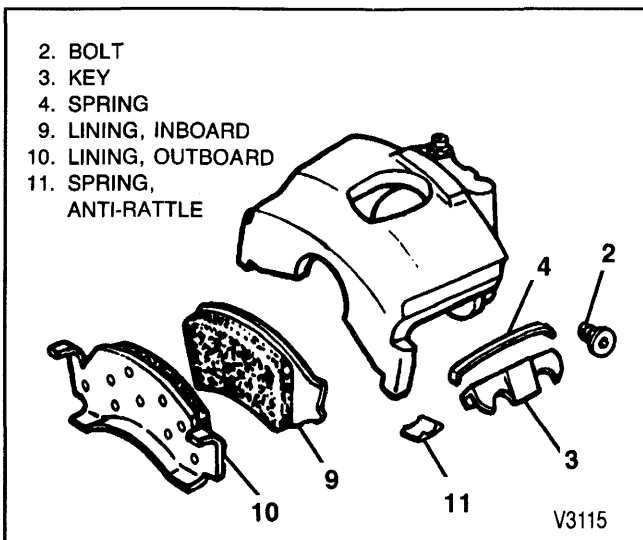


Figure 4—Replacing the Disc Brake Pads

Inspect

- The inside of the caliper assembly for signs of fluid leakage. If any is found, refer to "Unit Repair."

Clean

- Use a wire brush to remove any corrosion from the machined surfaces of the anchor plate and caliper.

Install or Connect (Figures 3 and 4)

NOTICE: For steps 4 and 5, refer to "Notice" on page 5B2-1.

1. Lubricate caliper and anchor plate sliding surfaces with Aeroshell Grade 5 lubricant or equivalent.
2. Caliper assembly (1).

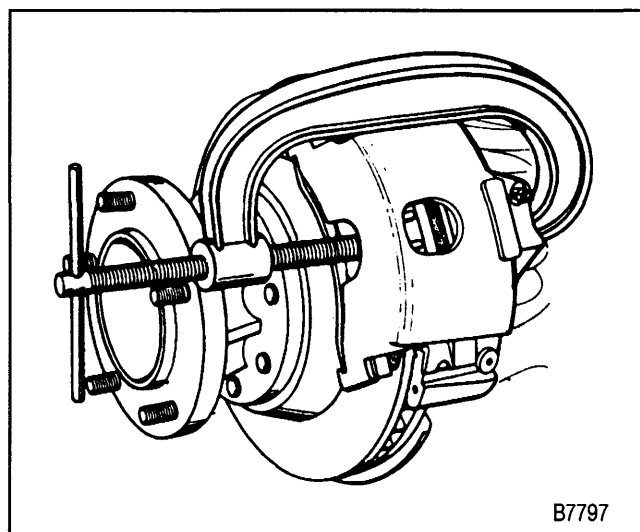


Figure 5—Compressing the Caliper Piston

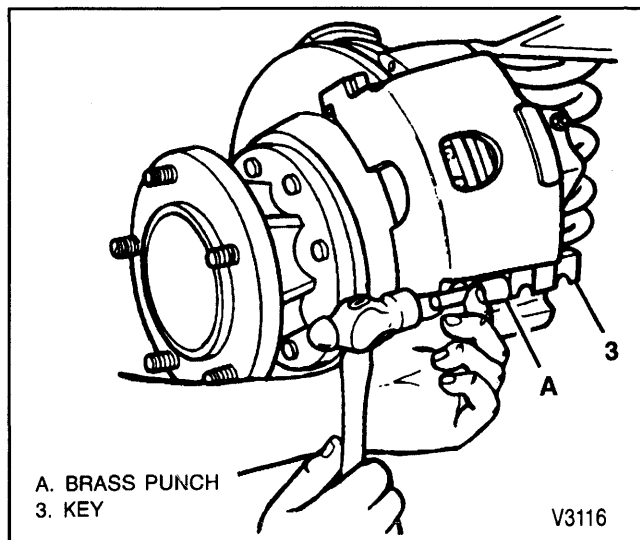


Figure 6—Removing the Caliper Support Key

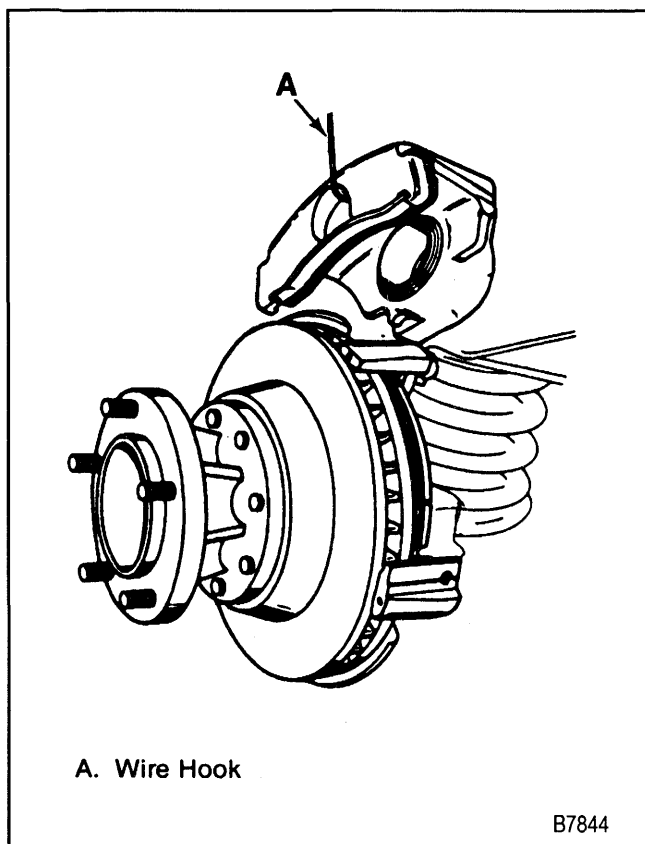


Figure 7—Suspending the Caliper

NOTICE: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

3. Spring (4) and support key (3) (figure 8).
 - Use a brass punch and hammer to drive the support key in place.
4. Bolt (2).
 - The boss on the bolt must fit into the circular cutout in the key.



Tighten

- Bolt (2) to 20 N·m (15 lbs. ft.).

5. Brake hose.



Tighten

- Brake hose bolt to 45 N·m (33 lbs. ft.).

6. Bleed system. Refer to SECTION 5.
7. Tire and wheel. Refer to SECTION 3E.
8. Lower the vehicle.



Important

- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal is obtained. Check the brake fluid level in the master cylinder after pumping the brakes.

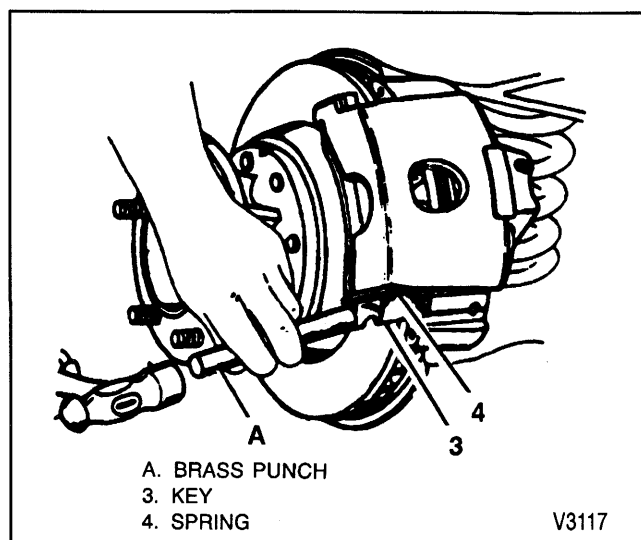


Figure 8—Installing the Caliper Support Key

LININGS

GM replacement brake lining material is recommended for all vehicles to maintain the balance between front and rear brake performance. GM replacement brake parts have been carefully selected to provide the proper brake balance for the purposes of stopping distance and control over the full range of operating conditions. Installation of front or rear lining material with performance different from that of GM replacement parts recommended for this vehicle can change the intended brake balance of this vehicle.



Remove or Disconnect (Figures 4 and 7)

1. Caliper. Refer to "Caliper."
 - Suspend the caliper (figure 7).

NOTICE: Do not allow calipers to hang from the flexible hoses. Doing so can damage the hoses.

2. Inboard lining (9).
3. Anti-rattle spring (11).
4. Outboard lining (10).



Clean

- Use a wire brush to remove any corrosion from the machined surfaces of the steering knuckle and caliper.



Install or Connect (Figure 4)

1. Inboard lining (9) and anti-rattle spring (11).
2. Outboard lining (10).
3. Caliper assembly. Refer to "Caliper."

NOTICE: Make sure the brake hose is not twisted or kinked after installation or damage to the hose could result.

5B2-6 REAR DISC BRAKES

! Important

- Before moving the vehicle, pump the brake pedal several times to make sure it is firm. Do not move the vehicle until a firm pedal is obtained. Check the brake fluid level in the master cylinder after pumping the brakes.

BURNISHING LININGS AND ROTORS

After the brake linings are replaced and/or the rotors refinished, the new braking surface should be broken in, or "burnished." To do this, make 20 stops from 30 mph using medium to firm brake pedal pressure. During this procedure, use care to avoid overheating the brakes.

CALIPER AND ANCHOR PLATE WEAR ADJUSTMENTS

Bendix calipers have oversize replacement keys available to compensate for wear at the caliper to anchor plate contact points. The keys are identified by marks as indicated in figure 9. If wear is excessive, a rattle sound can be heard from the front brake area. Use the following procedure to measure and correct this condition.

Refer to figure 9.

1. Remove caliper. Refer to "Caliper."
2. Clean surfaces A, B, C, and D with a wire brush.
3. Smooth any deep nicks and/or gouges with a file.
4. Measure caliper contact surface for wear.
 - A. Lay a straight edge across caliper surfaces "C" and "D."

- B. Measure the maximum depth of any wear on these surfaces using feeler gauges.
- C. Replace calipers worn to a depth of 0.050 inch or more.

5. Measure caliper to anchor plate wear.

- A. Install caliper back in the knuckle.
- B. Install a new standard size key without the spring.
- C. Install the key retention bolt.
- D. Insert a screw driver into the center of key bumper gap.
- E. Pry firmly to ensure that caliper is seated at surfaces "A," "B," and "C."
- F. Measure the bumper gap with largest feeler gauge(s) that will fit into the gap its full length.
- G. Select a replacement key according to the table in "Specifications."

6. Install caliper. Refer to "Caliper."

ANCHOR PLATE

For information on anchor plate service, refer to SECTION 4B1.

ROTOR

For information on rotor removal and installation, refer to SECTION 4B1.

PARKING BRAKE ADJUSTMENT

For information on adjusting the parking brake, refer to SECTION 5F.

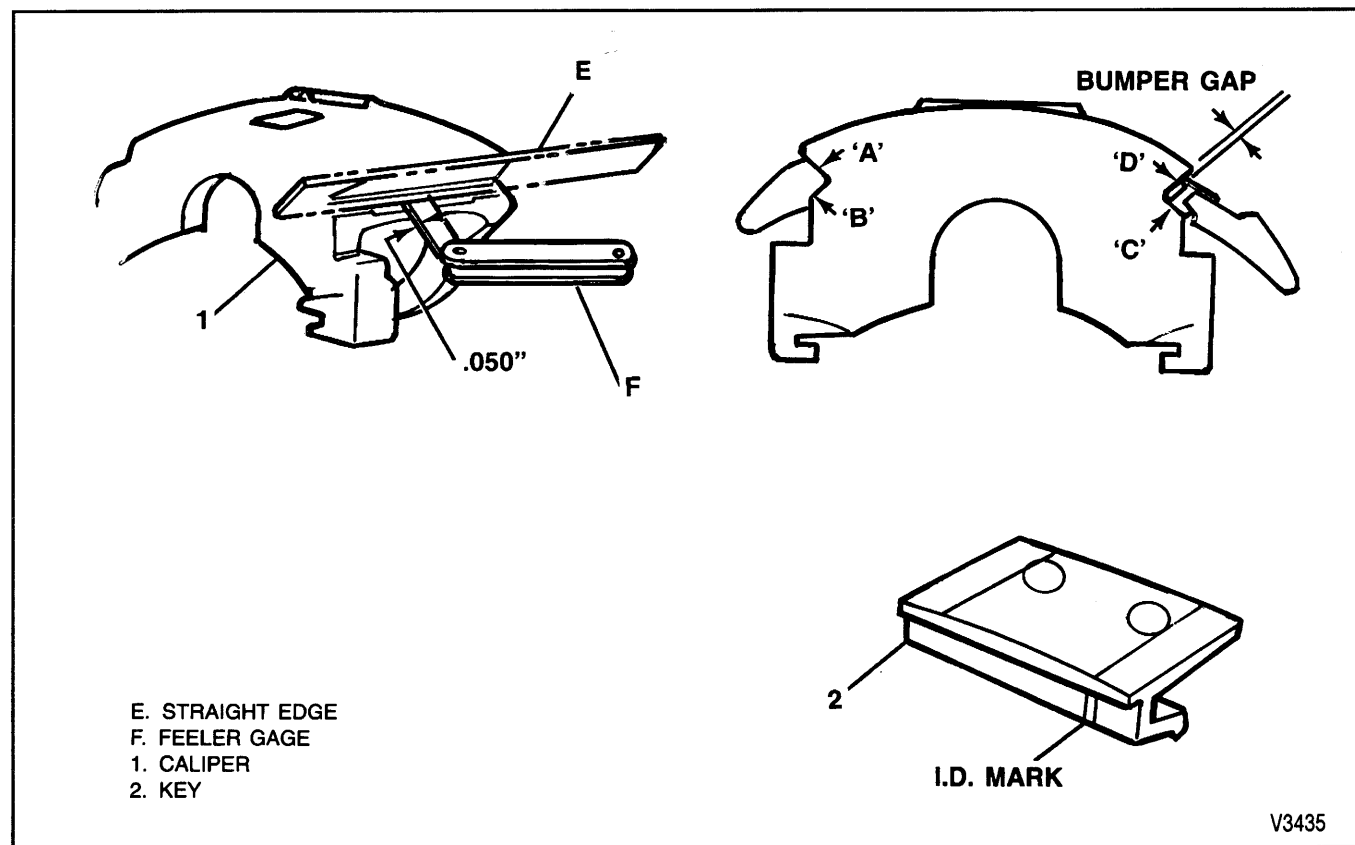


Figure 9—Bendix Caliper Wear Adjustment

UNIT REPAIR

REFINISHING BRAKE ROTORS

You do not need to refinish brake rotors when doing routine brake maintenance such as replacing worn brake shoe and lining assemblies. Refinish rotors only under the following circumstances:

1. There is a complaint of brake pulsation.
2. There are heat spots or excessive scoring.

Brake rotors have a minimum thickness dimension cast into them. This dimension is the minimum wear dimension and not a refinish dimension. Do not use a brake rotor that will not meet the dimensions shown in the specifications chart after refinishing. A rotor that is too thin will not have the proper heat transfer capabilities. Replace it with a new rotor.

Accurate control of rotor tolerances is necessary for the proper performance of disc brakes. Machining should be done only with precision equipment. Service the machining equipment on a regular basis following the manufacturer's recommended maintenance procedures.

When refinishing rotors, make sure the attaching adapters, tool holders, vibration dampeners, and tool bits are in good condition. Always use sharp cutting tools or bits and use only replacement cutting bits recommended by the equipment manufacturer. Dull or worn tools leave a poor surface finish that will affect initial brake performance. Always use vibration dampening attachments when refinishing braking surfaces. These attachments eliminate tool chatter to allow for a better surface finish. Make sure these adaptors are clean and free of nicks.

Following are two recommended procedures that achieve adequate results using two different off-vehicle drum/disc brake lathes. If any other lathe is used, follow that manufacturer's instructions and recommendations.

AMMCO BRAKE LATHE

	Rough Cut	Finish Cut
Spindle Speed	150 rpm	150 rpm
Depth of Cut (per side)	0.127 mm (0.005 in.)	0.051 mm (0.002 in.)
Total Cross Feed (per revolution)	0.152-0.254 mm (0.006-0.010 in.)	0.051 mm max. (0.002 in.)
Vibration Damp.	Yes	Yes
Swirl Pattern - 120 Grit	No	Yes

T2914

ACCU. TURN BRAKE LATHE, GM DEALER EQUIPMENT (One Cut Refinishing Procedure)

Spindle Speed	150 rpm
Tool Cross Feed (per rev.)	0.076 mm (0.003 in.)
Tool Bit Nose Radius	1/64
Vibration Damper	Yes
Swirl Pattern - 120 Grit	Yes

T2915

Locate the deepest score and turn the rotor micrometer knobs until the tool bit bottoms out at the deepest point of the score. Zero the scale and back out the tool bits. Advance the cutter hand-wheel until the bits have cleared the inner edge of the rotor face. Adjust the micrometer knobs for approximately 0.0127 mm (0.005 in.) more than the first reading. This will ensure clearing the rotor in one cut.

It is very important that you make the rotor surface non-directional by dressing the rotor surfaces with a sanding disc power tool such as Ammco 8350 Safe Swirl Disc Rotor Grinder using 120 grit aluminum oxide sandpaper. Sand each rotor surface using moderate pressure for a minimum of 60 seconds. An alternate method is to use a sanding block with 150 grit aluminum oxide sandpaper. With the rotor turning at approximately 150 rpm, sand each rotor surface using moderate pressure for a minimum of 60 seconds. After sanding the rotor, clean each surface with denatured alcohol or a suitable brake cleaner.

The finished rotor surface should be as close to that of a new rotor as possible. Failure to obtain the best possible rotor finish can affect initial braking performance.

CALIPER



Remove or Disconnect (Figure 10)

1. Fluid from caliper.
2. Pad interior of caliper with clean shop towels.

CAUTION: Do not place your fingers in front of the piston in an attempt to catch or protect it when applying compressed air. This could result in serious injury.

NOTICE: Use just enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.

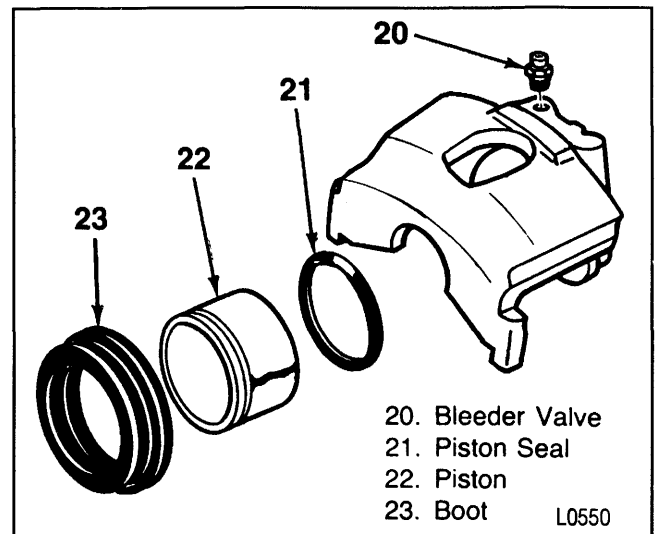


Figure 10—Caliper Components

5B2-8 REAR DISC BRAKES

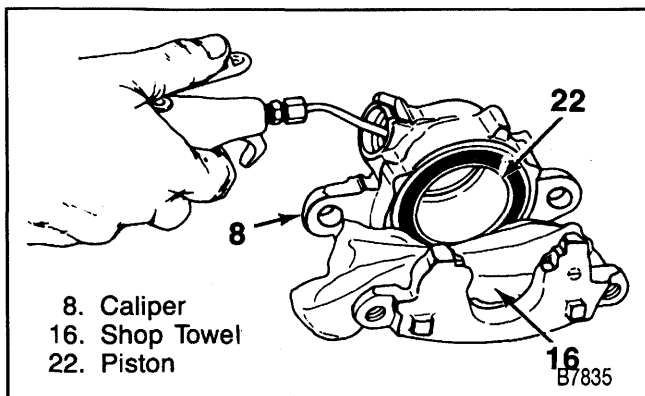


Figure 11—Removing the Piston

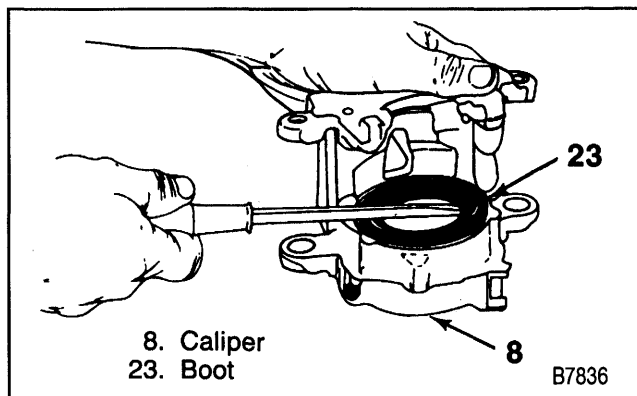


Figure 12—Removing the Boot

3. Piston (22).
 - Direct compressed air into caliper fluid inlet (figure 11).
4. Boot (23) (figure 12).
5. Piston seal (21).
 - Do not use any type of metal tool.
6. Bleeder valve (20).



Clean

- Bleeder valve, caliper bore, caliper passages, and piston with denatured alcohol. Use dry, filtered, compressed air to dry parts and blow out passages.



Inspect

- Piston for scoring, corrosion, and damage to the chrome plating. Replace it if any of these conditions are found.
- Caliper bore for scoring, pitting, or corrosion. Use crocus cloth to polish out any light corrosion. Replace the caliper if the corrosion cannot be removed.



Install or Connect (Figure 10)

Tool Required:

J 24548 Piston Seal Installer

1. Lubricate new piston seal, caliper bore, piston, and seal lips on boot with clean brake fluid.
2. Piston seal (21).
 - Make sure seal is not twisted in caliper bore groove.
3. Boot (23) on J 24548.
 - A. Place large diameter of boot over tool first and carefully work smaller diameter onto tool.
 - B. Slide large diameter off tool.
4. Large lip of boot in caliper bore groove.
 - Lip of boot must firmly seat in groove.
5. Piston (22) inside J 24548 (figure 13).

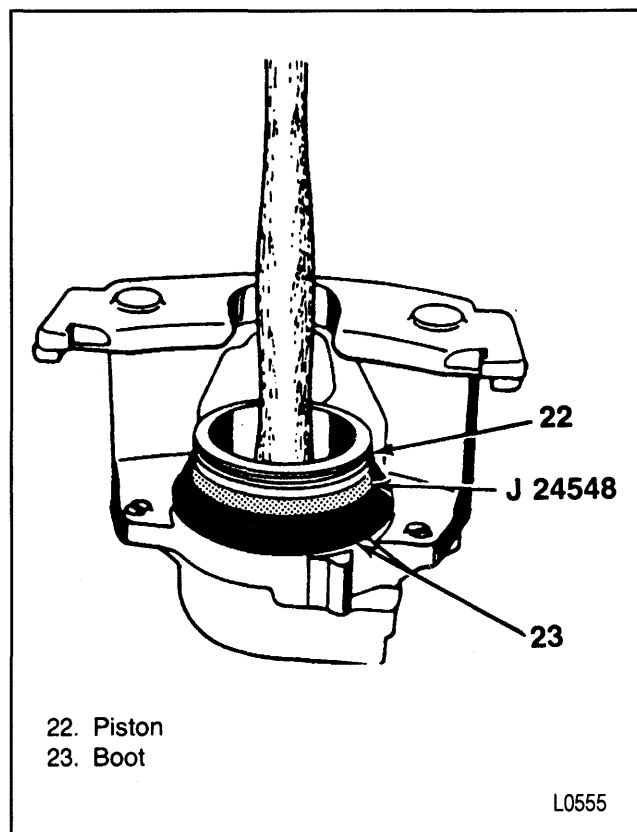


Figure 13—Installing the Piston

6. Piston halfway into bore.
 - A. Remove J 24548.
 - B. Make sure boot is firmly seated.

NOTICE: Refer to "Notice" on page 5B2-1.

7. Bleeder valve (20).



Tighten

- Bleeder valve to 7 N.m (62 lbs. in.)

SPECIFICATIONS

BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 2.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

ROTOR THICKNESS

ORIGINAL	THINNEST (REFINISHING)	REPLACEMENT (DISCARD)
31.75 mm (1.25 in.)	31.25 mm (1.23 in.)	30.86 mm (1.215 in.)
32 mm (1.26 in.)		
38.10 mm (1.50 in.)	37.59 mm (1.480 in.)	37.21 mm (1.465 in.)
39.11 mm (1.54 in.)		

T2697

BENDIX CALIPER REPLACEMENT KEY SPECIFICATIONS

Bumper Gap	Replacement Key	P/N
0.0 - 0.060	Std. Size - I	14023439
0.061 - 0.100	0.040 Oversize - II	14026793
0.101 - 0.140	0.080 Oversize - III	14026794
0.141 - 0.180	0.120 Oversize - IIII	14026795
0.181 - 0.220	0.160 Oversize - IIIII	14026796
0.221 -	Replace Caliper and Anchor Plate or Steering Knuckle	

T2961

FASTENER TIGHTENING SPECIFICATIONS

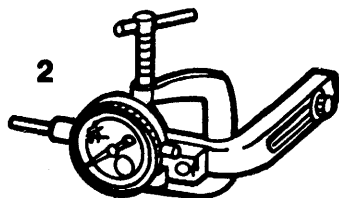
Item	N·m	Ft. Lbs.	In. Lbs.
Anchor Plate Mounting Bolt	240	177	—
Bleeder Valve	7	—	62
Brake Hose to Caliper Bolt	45	33	—
Caliper Support Key Bolt	20	15	—

T2948

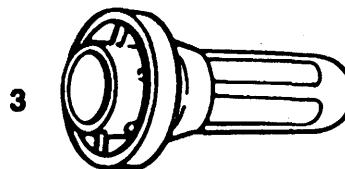
SPECIAL TOOLS



J 24548



1. Piston Seal Compressor
2. Dial Indicator
3. Piston Seal Installer



J 28735-A

SECTION 5C1

LEADING/TRAILING DRUM BRAKES

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, by cleaning brake parts with a dry brush or with compressed air. Many earlier models or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: Any new drum must have the protective coating removed from the friction surface before being placed in service. Use Goodwrench Brake Parts Cleaner (GM P/N 12345754) or equivalent, and wipe the surface clean with clean cloths. Do not use gasoline, kerosene, or other oil base solvents which may leave an oily residue. This residue is damaging to brake linings and flammable.

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GENERAL DESCRIPTION

Leading/trailing drum brakes are used on vehicles with a 6400 pound GVW rating. Both brake shoes are held against the wheel cylinder pistons by the upper return spring and the fixed anchor plate by the lower return spring. Applying the brakes causes the wheel cylinder pistons to move both shoes out to contact the drum. With forward wheel rotation, the forward brake shoe wraps into the drum and becomes self-energized.

With reverse wheel rotation, the rear brake shoe is self-energized. Force from the brake shoes is transferred to the anchor plate, through the backing plate, and finally to the axle flange. Adjustment is automatic and occurs on any brake application. It is normal for the front (leading) shoe and lining assembly to wear faster than the rear (trailing) shoe and lining assembly.

DIAGNOSIS

LINING INSPECTION

Inspect the linings every 6,000 miles and any time the wheels are removed (tire rotation, etc.). Inspect the shoe and lining assemblies for wear by removing the brake drum. Replace shoe and lining assemblies when the thickness of any lining is worn to within 0.76 mm (0.030 in.) of the shoe. Replace riveted shoe and lining assemblies when the lining is worn to within 0.76 mm (0.030 in.) of any rivet head. Always replace shoe and lining assemblies as a complete axle set.

DRUM INSPECTION

Any time you remove the brake drums, thoroughly clean and inspect them for cracks, scores, deep grooves, and out-of-round.

SURFACE FINISH

Slight scoring can be cleaned up with fine emery cloth. Heavy or extensive scoring causes excessive lining wear. The drum braking surface will need machining to remove these scores.

If the drum is grooved and the linings are slightly worn, the drum should not be machined. Instead, polish the drum braking surface with fine emery cloth. Eliminating all of the drum grooves and ridges on the lining would require removing too much metal and lining material. The grooves and ridges match and satisfactory service can be obtained by leaving them alone.

INSIDE DIAMETER CHECK

Measure the inside diameter of the brake drum at two or more places around the circumference of the braking surface. The measurements must be made at the same distance in from the the edge of the drum. Compare the results with the wear specifications at the end of this section in "Unit Repair."

TAPER CHECK

Measuring a drum for taper involves taking measurements at the inner and outer edges of the machined surface at two or more places around the drum. These measurements should be equal.

ON-VEHICLE SERVICE

DRUM

For brake drum on-vehicle service procedures, refer to SECTION 4B1.

LININGS

GM replacement brake lining material is recommended for all vehicles to maintain the balance between front and rear brake performance. GM replacement brake parts have been carefully selected to provide the proper brake balance for the purposes of stopping distance and control over the full range of operating conditions. Installation of front or rear lining material with performance different from that of recommended GM replacement parts can change the intended brake balance of this vehicle.



Remove or Disconnect (Figure 1)

1. Raise vehicle and support with safety stands.
2. Mark relationship of wheel to hub.
3. Tire and wheel. Refer to SECTION 3E.

CAUTION: Refer to "Caution" on page 5C1-1.

4. Mark relationship of drum to axle.
5. Drum. Refer to SECTION 4B1.

• If the drum is difficult to remove:

- A. Make sure the parking brake is released.
- B. Back off the parking brake cable adjustment.
- C. Remove the access hole plug (25) from the backing plate and insert a screwdriver through the hole to push the parking brake lever off its stop (figure 2).
- D. Use a rubber mallet to tap gently on the outer rim of the drum and/or around the inner drum diameter. Be careful to not deform the drum by excessive beating.

6. Actuator spring (1) and adjuster actuator (3).

- A. Raise the lever arm of the actuator (3) until the upper end is clear of the slot in the adjuster screw (12) (figures 2 and 3).

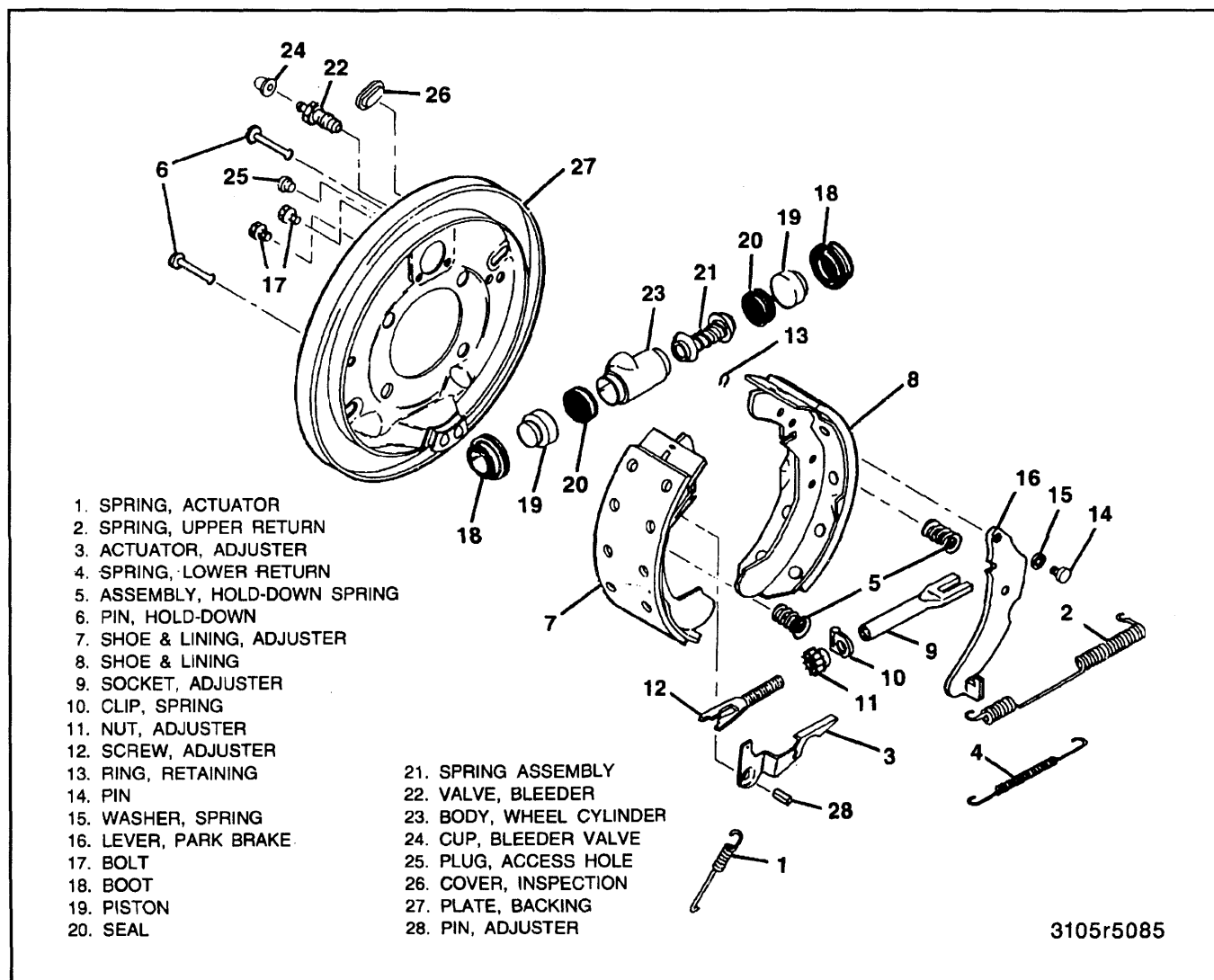


Figure 1—Leading/Trailing Drum Brake

5C1-4 LEADING/TRAILING DRUM BRAKES

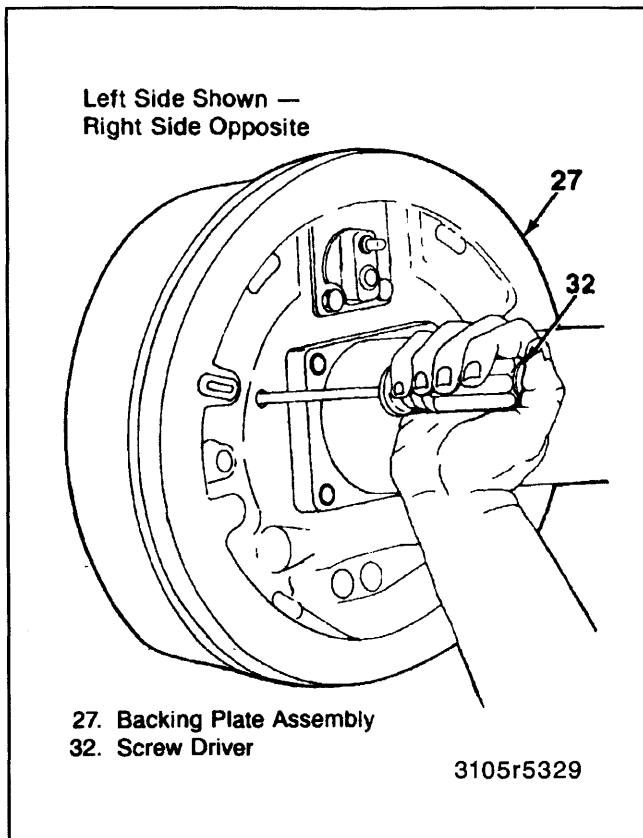


Figure 2—Pushing the Parking Brake Lever Off its Stop

- B. Slide the actuator (3) off of the adjuster pin (28).
- C. Disconnect the actuator spring (1) from the shoe (7).
7. Hold-down spring assemblies (5) and pins (6).
8. Lower return spring (4).
 - A. Pull the bottom ends of the shoes apart.
 - B. Lift the lower return spring (4) over the anchor plate.
 - C. Allow the shoe ends to come together and release the spring.
9. Shoe and lining assemblies (7 and 8) along with the upper return spring (2) and adjusting screw assembly.
 - A. Be careful not to damage the wheel cylinder boots.
 - B. Bring the bottom ends of the shoes together (overlap if necessary) so the upper shoe ends clear the wheel cylinder boots.
 - C. Spread the bottom of the assembly to clear the axle flange.
10. Upper return spring (2) and adjusting screw assembly from the shoes.
11. Retaining ring (13), pin (14), spring washer (15), and parking brake lever (16).



Inspect

- If any parts show signs of discoloration from heat, over-stress, or wear, replace them.
- Threads of the adjuster screw (12) for smooth rotation over the full length.

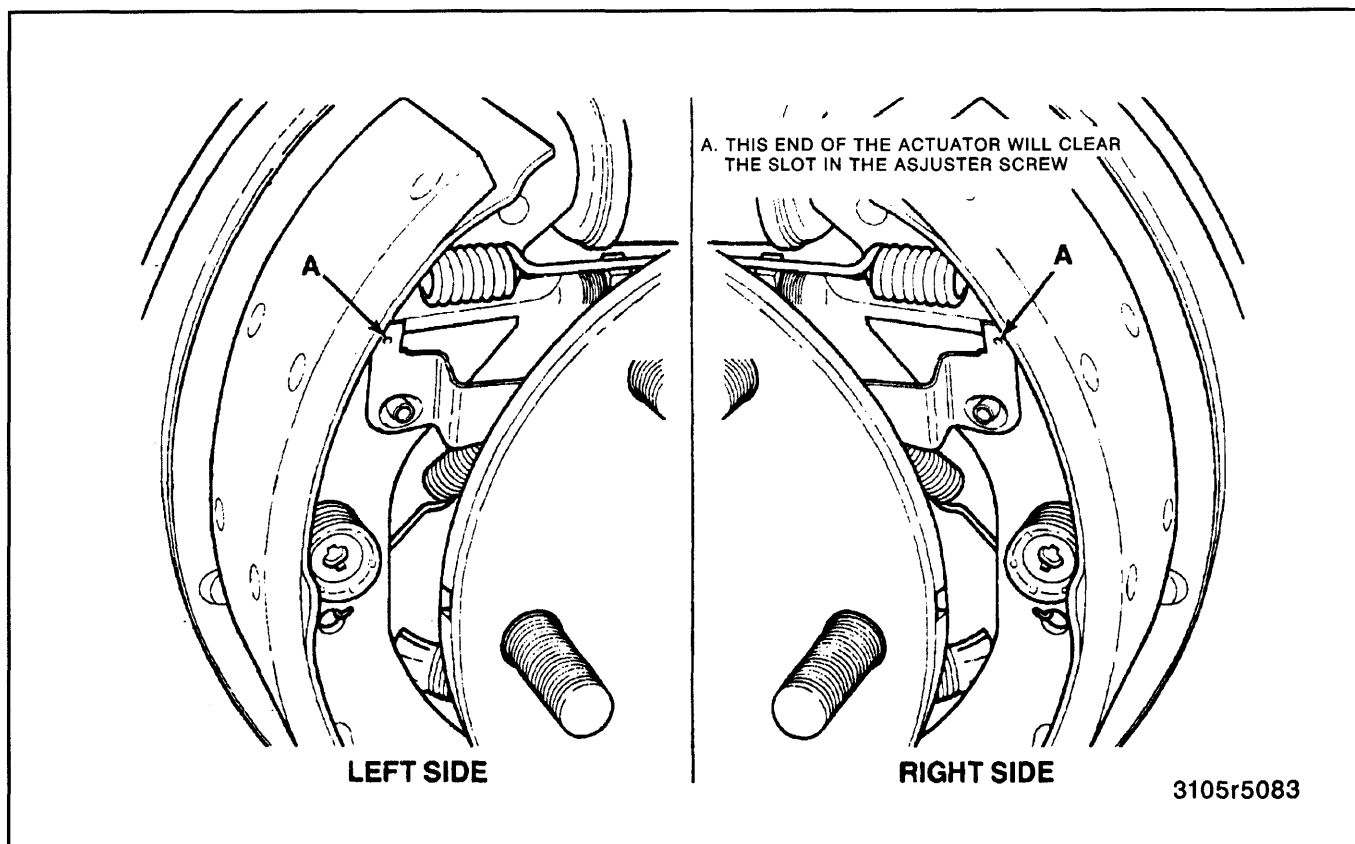


Figure 3—Removing the Adjuster Actuator



Clean

- Adjuster screw (12), nut (11), spring clip (10), and adjuster socket (9) in denatured alcohol.



Install or Connect (Figures 1 and 4)

1. Parking brake lever (16), spring washer (15), pin (14), and retaining ring (13).
 - The concave side of the spring washer should face the parking brake lever.
2. Adjuster pin (28) in the shoe (7) so the pin projects 6.8 to 7.0 mm (0.268 to 0.276 inch) from the side of the shoe web where the adjuster actuator is installed.
3. Brake lubricant (GM P/N 5450032) or equivalent to the threads of the adjuster screw (12) and inside diameter and face of the socket (9).
 - Adequate lubrication is achieved when there is a continuous bead of lubricant at the open end of the adjuster nut (11) and socket (9) when the threads are fully engaged.
4. Upper return spring (2).
 - A. Lay the shoes (7 and 8) on a clean, flat work surface in the position they will be in when installed on the backing plate.
 - B. The shoe with the parking brake lever goes to the rear of the vehicle.

NOTICE: Do not over-stretch the upper return spring. Damage can occur if it is stretched to more than 204.2 mm (8.04 inches).

5. Adjusting screw assembly.
 - The adjusting screw assembly should engage the adjuster shoe (7) and parking brake lever (16) respectively.
 - Make sure the spring clip (10) faces the backing plate.
6. Lubricate the shoe pads on the backing plate with a thin coat of white lithium grease.
7. Shoe and lining assemblies (7 and 8), upper return spring (2), and adjusting screw assembly.

- A. Be careful not to damage the wheel cylinder boots.
- B. Overlap the bottoms of the shoes so the upper shoe ends clear the wheel cylinder boots.
- C. Make sure the upper shoe ends rest on the wheel cylinder piston ends.
- D. Do not place the lower shoe web ends under the anchor plate until the lower return spring is installed.

NOTICE: Do not over-stretch the lower return spring. Damage can occur if it is stretched to more than 107.3 mm (4.22 inches).

8. Lower return spring (4).
 - A. Bring the ends of the shoe and lining assemblies (7 and 8) together over the anchor plate.
 - B. Hook the spring ends to the shoe web holes.
 - C. Spread the lower ends of the shoe and lining assemblies to clear the anchor plate.
 - D. Position the shoes against the backing plate and release them.
 - E. Pull the spring into the groove at the bottom of the anchor plate.
9. Hold-down pins (6) and spring assemblies (5).
10. Adjuster actuator (3) over the end of the adjuster pin (28) so the top leg engages the notch in the adjuster screw (figure 3).

NOTICE: Do not over-stretch the actuator spring (1). Damage can occur if it is stretched to more than 83 mm (3.27 inches).

11. Actuator spring (1).
 - Make sure the free end of the adjuster actuator (3) engages the notch of the adjuster nut.
12. Parking brake cable to the parking brake lever (16).



Adjust

- Parking brake. Refer to SECTION 5F.
13. Drum.
 - Align the marks made during disassembly.
 14. Tire and wheel. Refer to SECTION 3E.
 - Align the marks made during disassembly.

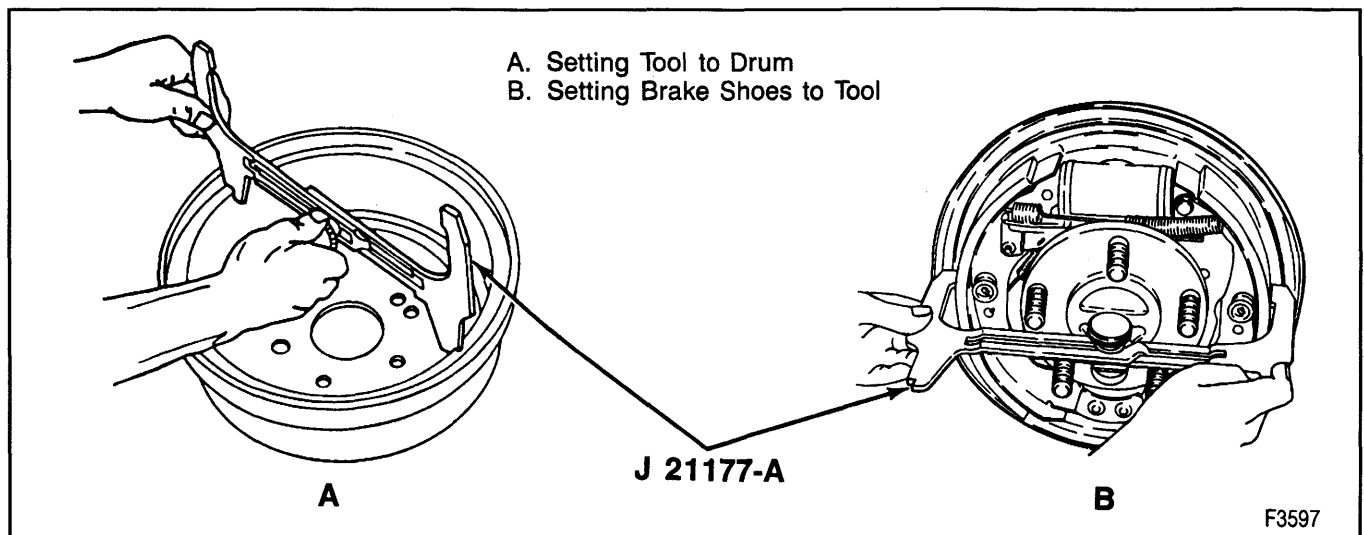


Figure 4—Measuring the Drum and Shoes for Adjustment

5C1-6 LEADING/TRAILING DRUM BRAKES

WHEEL CYLINDER

Remove or Disconnect (Figure 5)

1. Shoes and linings. Refer to "Linings" in this section.



Clean

- Dirt and foreign material from around the wheel cylinder.
2. Inlet pipe.
 - Plug the pipe to prevent fluid loss and contamination.
 3. Bolts (22).
 4. Wheel cylinder (30).

Install or Connect (Figure 5)

NOTICE: For steps 2 and 3, refer to "Notice" on page 5C1-1.

1. Wheel cylinder (30).
2. Bolts (22).



Tighten

- Bolts (22) to 20 N·m (15 lbs. ft.).
3. Inlet pipe.



Tighten

- Fitting to 17 N·m (13 lbs. ft.).
4. Shoes and linings. Refer to "Linings" in this section.
 5. Bleed brake system. Refer to SECTION 5.

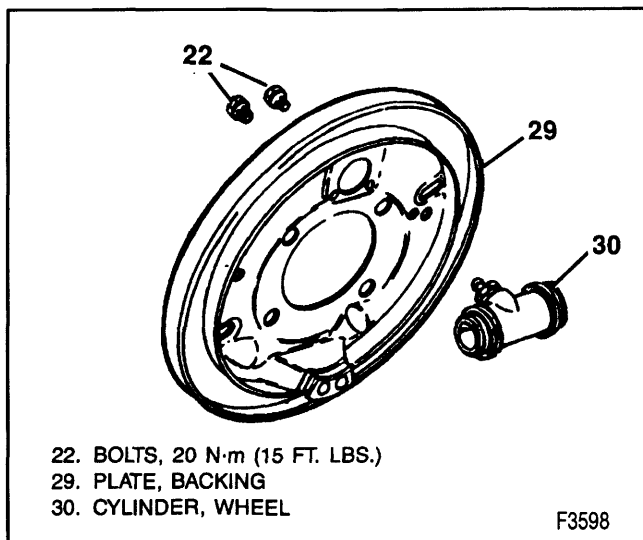


Figure 5—Wheel Cylinder Replacement

BACKING PLATE

Remove or Disconnect (Figure 6)

CAUTION: Refer to "Caution" on page 5C1-1.

1. Linings. Refer to "Linings" in this section.
2. Wheel cylinder. Refer to "Wheel Cylinder" in this section.
3. Bolts (31) and washers (32).
4. Backing plate (29).



Install or Connect (Figure 6)

1. Backing plate (29).

NOTICE: Refer to "Notice" on page 5C1-1.

2. Bolts (31) and washers (32).



Tighten

- Bolts (31) to 70 N·m (52 lbs. ft.)
3. Wheel cylinder. Refer to "Wheel Cylinder" in this section.
 4. Linings. Refer to "Linings" in this section.
 5. Adjust brakes. Refer to "Adjustment" in this section.
 6. Bleed brakes. Refer to SECTION 5.

ADJUSTMENT

A manual adjustment of the rear drum brakes is required after replacing the rear linings.

CAUTION: Refer to "Caution" on page 5C1-1.

1. Remove the lanced area in the backing plate.
2. Turn the adjusting screw until the wheel can just be turned by hand.
3. The brake drag should be equal at both wheels.

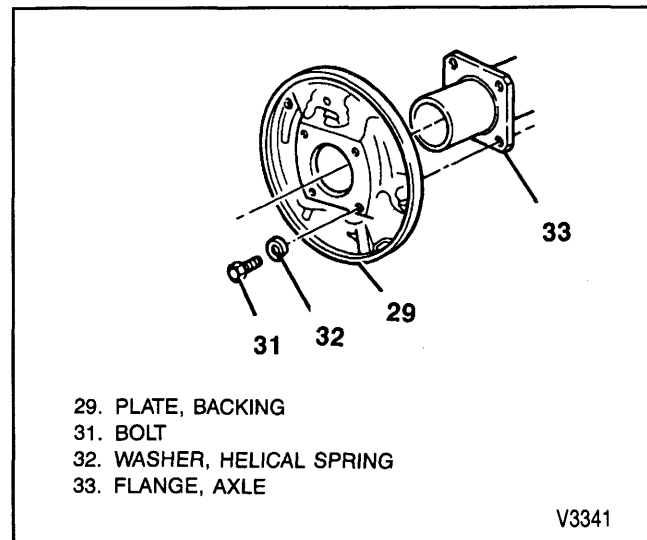


Figure 6—Backing Plate Replacement

4. Back off the adjusting screw 20 notches.

- Brakes should have no drag after the adjusting screw is backed off about 10 notches. If a heavy drag is still present, refer to SECTION 5F.

5. Install an adjusting hole cover in the backing plate.

6. Check the parking brake adjustment. Refer to SECTION 5F.

PARKING BRAKE ADJUSTMENT

For information on adjusting the parking brake, refer to SECTION 5F.

UNIT REPAIR

DRUMS

CRACKED, SCORED, OR GROOVED

A cracked drum is unsafe for further service and must be replaced. Do not attempt to weld a cracked drum.

Smooth up any slight scores. Heavy or extensive scoring will cause excessive lining wear, and it may be necessary to resurface the drum braking surface.

If the linings are slightly worn (but still reusable) and the drum is grooved, polish the drum with fine emery cloth but do not refinish. Eliminating all grooves in the drum and smoothing the ridges on the lining would require removing too much metal and lining. If left alone, the grooves and ridges match and satisfactory service can be obtained.

If replacing the brake linings, always refinish a grooved drum. Using a grooved drum with new linings will wear the linings and make proper brake performance difficult to obtain.

OUT-OF-ROUND OR TAPERED

An out-of-round or tapered drum prevents accurate brake shoe adjustment and is likely to cause excessive wear of other brake parts due to its eccentric action. An out-of-round drum can also cause severe and irregular tire tread wear as well as a pulsating brake pedal. When the drum exceeds the specification limits in taper and/or out-of-round, refinish the drum to true up the braking surface. Out-of-round and taper can be accurately measured with an inside micrometer and extension rods.

When measuring a drum for out-of-round and taper, take measurements at the open and closed edges of the machined surface and at right angles to each other.

REFINISHING

If you determine a drum needs refinishing, remove only enough metal to obtain a true, smooth braking surface. If a drum does not clean up when refinished to the maximum refinish diameter, as shown in "Specifica-

tions" at the end of this section, replace it. Removal of more metal will affect heat dissipation and can cause drum distortion.

All brake drums have a maximum diameter cast into them. This diameter is the maximum wear diameter and not a refinish diameter. Do not refinish a brake drum that will not meet the "Specifications" at the end of this section; instead, replace it.

When refinishing a brake drum, resurface the drum to a dimension no more than 0.76 mm (0.030 inch) less than the discard diameter. The refinish diameter is the maximum diameter the drum can be refinished to and still allow safe braking action. If you exceed this diameter, the brake drum will wear beyond the discard diameter during normal brake use.

Always use sharp cutting tools or bits. Dull or worn tools leave a poor surface finish that will affect initial braking performance. Always use vibration dampening attachments when you refinish braking surfaces. These attachments eliminate tool chatter so you can obtain a better surface finish.

The best speed for refinishing braking surfaces is a spindle speed of 150 rpm. Crossfeed for rough cutting should range from 0.15 to 0.25 mm (0.006 to 0.010 inch) per revolution. Finish cuts should be made at crossfeeds no greater than 0.05 mm (0.002 inch) per revolution.

New Replacement Drum Refinishing

When installing new brake drums, do not refinish the braking surface. These parts are already at the correct level of surface finish.

BALANCE

During manufacturing, weights are used to balance brake drums. Do not remove these weights.

After you refinish brake drums, or when maintaining wheel balance is difficult, check the drums for balance. They can be checked on most off-vehicle balancers. If found to be out of balance, replace the drum.

WHEEL CYLINDER



Remove or Disconnect (Figure 7)

1. Bleeder valve (1).
2. Boots (4).
3. Pistons (3).
4. Seals (2).
5. Spring assembly (5).



Inspect

- Cylinder bore for scoring and corrosion.
- Spring assembly for signs of discoloration due to heat. Replace if necessary.



Clean

- Inside the cylinder bore with crocus cloth. If the bore is still scored, replace the wheel cylinder.
- Cylinder bore with clean brake fluid.



Install or Connect (Figure 7)

- Lubricate pistons, seals, and cylinder bore with clean brake fluid.

1. Spring assembly (5).
2. Seals (2).
3. Pistons (3).
4. Boots (4).
5. Bleeder valve (1).

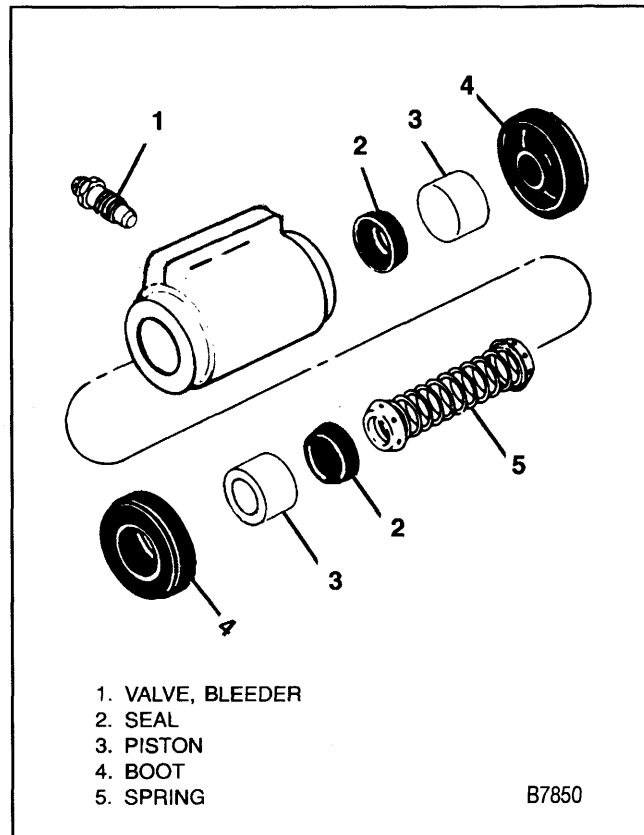


Figure 7—Wheel Cylinder Components



Tighten

- Bleeder valve to 7 N·m (62 lbs. in.).

SPECIFICATIONS

BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 2.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

DRUM DIAMETERS

ORIGINAL	MAXIMUM (REFINISH)	REPLACEMENT (DISCARD)
254 mm (10 in.)	255.30 mm (10.05 in.)	356.30 (10.09 in.)
283.21 mm (11.15 in.)	284.73 mm (11.21 in.)	285.50 (11.24 in.)
330.20 mm (13 in.)	331.72 mm (13.06 in.)	332.49 (13.09 in.)

T2216

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Ft. Lbs.	In. Lbs.
Backing Plate Mounting Bolts.....	70	52	—
Bleeder Valve	7	—	62
Pipe Fitting	17	13	—
Wheel Cylinder Mounting Bolts	20	15	—

T2953

SPECIAL TOOL

1.



J 21177-A

1. DRUM TO BRAKE SHOE CLEARANCE GAGE

3105r5084

5C1-10 LEADING/TRAILING DRUM BRAKES

NOTES

SECTION 5C2

DUO-SERVO DRUM BRAKES

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, by cleaning brake parts with a dry brush or with compressed air. Many earlier models or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: A new drum must have the protective coating removed from the friction surface before being placed in service. Use Goodwrench Brake Parts Cleaner (GM P/N 12345754) or equivalent and wipe the surface clean with clean cloths. Do not use gasoline, kerosene, or other oil base solvents that can leave an oily residue. This residue is damaging to brake linings and flammable.

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GENERAL DESCRIPTION

This section covers service procedures for duo-servo drum brakes. Applying the brakes cases the wheel cylinder piston to force the leading edge of the primary shoe and lining assembly to contact the rotating drum. The shoe tries to rotate with the drum and transfers force to the secondary shoe and lining assembly through the star-wheel adjuster. The secondary shoe's lining leading edge "bites" into the drum and tries to rotate, just like the primary shoe. Since the shoes cannot rotate, they wedge themselves into the drum. The

rotating torque from the shoes increases the braking force applied by the wheel cylinder. Because of this wedging action, the design is a duo-servo, as opposed to a single-servo design where the wheel cylinder pressure alone is the source of braking force.

The torque from the brake shoes is transferred through the backing plate to the axle flange. Brake adjustments are automatic and occur during reverse brake applications.

DIAGNOSIS

LINING INSPECTION

Inspect the linings every 6,000 miles and any time the wheels are removed (tire rotation, etc.). Inspect the shoe and lining assemblies for wear by removing the brake drum. Replace shoe and lining assemblies when the thickness of any lining is worn to within 0.76 mm (0.030 in.) of the shoe. Replace riveted shoe and lining assemblies when the lining is worn to within 0.76 mm (0.030 in.) of any rivet head. Always replace shoe and lining assemblies as a complete axle set.

DRUM INSPECTION

Any time you remove the brake drums, thoroughly clean and inspect them for cracks, scores, deep grooves, and out-of-round.

SURFACE FINISH

Slight scoring can be cleaned up with fine emery cloth. Heavy or extensive scoring causes excessive lining wear. The drum braking surface will need machining to remove these scores.

If the drum is grooved and the brake linings are slightly worn, the drum should not be machined. Instead, polish the drum braking surface with fine emery cloth. Eliminating all of the drum grooves and ridges on the lining would require removing too much metal and lining material. The grooves and ridges match and satisfactory service can be obtained by leaving them alone.

INSIDE DIAMETER CHECK

Measure the inside diameter of the brake drum at two or more places around the circumference of the braking surface. The measurements must be made at the same distance in from the edge of the drum. Compare the results with the wear specifications at the end of this section in "Unit Repair."

TAPER CHECK

Measuring a drum for taper involves taking measurements at the inner and outer edges of the machined surface at two or more places around the drum. These measurements should be equal.

ON-VEHICLE SERVICE

DRUM

For brake drum on-vehicle service procedures, refer to SECTION 4B1.

LININGS

GM replacement brake lining material is recommended for all vehicles to maintain the balance between front and rear brake performance. GM replacement brake parts have been carefully selected to provide the proper brake balance for the purposes of stopping distance and control over the full range of operating conditions. Installation of front or rear lining material with performance different from that of GM replacement parts recommended for this vehicle can change the intended brake balance of this vehicle.



Remove or Disconnect (Figure 1)

1. Raise vehicle and support with safety stands.
2. Mark relationship of wheel to hub.
3. Tire and wheel. Refer to SECTION 3E.



Inspect

4. Mark relationship of drum to axle.

CAUTION: Refer to "Caution" on page 5C2-1.

5. Drum.
6. Return springs (9 and 10).
7. Shoe guide (5).
8. Hold down springs (11).
9. Hold down pins (1).
10. Actuator lever (7) and lever pivot (12).
11. Lever return spring (13).
12. Actuator link (8).
13. Parking brake strut (6) and strut spring (14).
14. Parking brake lever (3).
15. Shoes (17 and 4).
16. Adjusting screw assembly (15).
17. Adjusting screw spring (16).

- All parts for discoloration due to heat or stress. Replace as needed.
- All parts for signs of wear. Replace as needed.

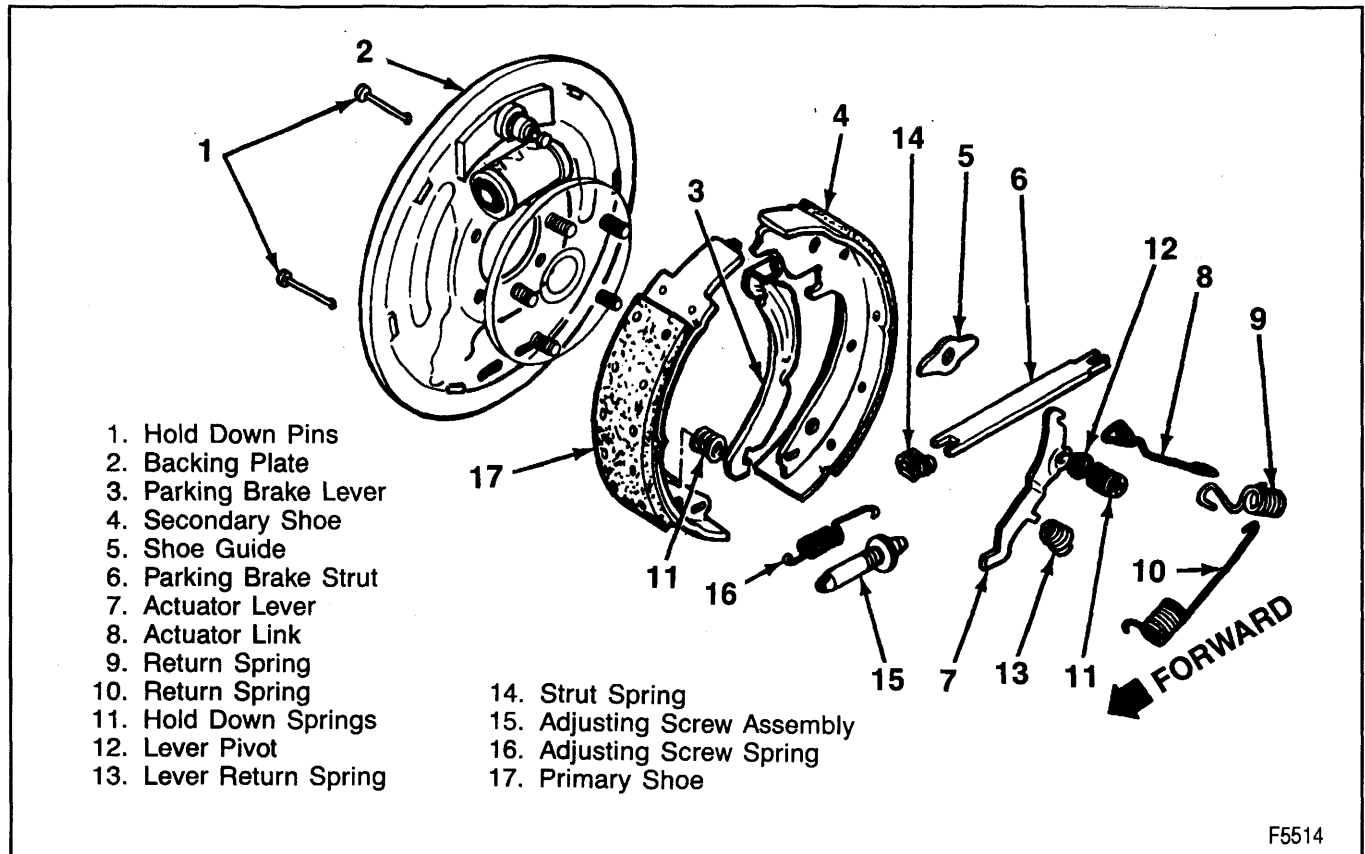


Figure 1—Duo-Servo Drum Brake Components

- Wheel cylinder for signs of leakage. If any is found, refer to "Wheel Cylinder."
- Brake drum for scoring and machining tolerance. Refer to "Refinishing."

15. Tire and wheel. Refer to SECTION 3E.

- Align the marks made during disassembly.

16. Adjust brakes. Refer to "Adjustment."

Install or Connect (Figure 1)

1. Lubricate shoe pads and adjusting screw threads with a thin coat of white lithium grease or equivalent.
2. Adjusting screw assembly (15) and adjusting screw spring (16) to both shoes (17 and 4).
 - The coils of the adjusting screw spring must not touch the adjusting screw.

! Important

- Do not interchange right and left adjusting screws.

3. Shoe assembly to the backing plate.
4. Parking brake lever (3).
5. Strut spring (14) onto the parking brake strut (6).
6. Parking brake strut (6).
7. Actuator lever (7) and lever pivot (12).
8. Actuator link (8).
9. Lever return spring (13).
10. Hold down pins (1).
11. Hold down springs (11).
12. Shoe guide (5).
13. Return springs (9 and 10).
14. Drum.

- Align the marks made during disassembly.

WHEEL CYLINDER

Remove or Disconnect (Figure 2)

CAUTION: Refer to "Caution" on page 5C2-1.

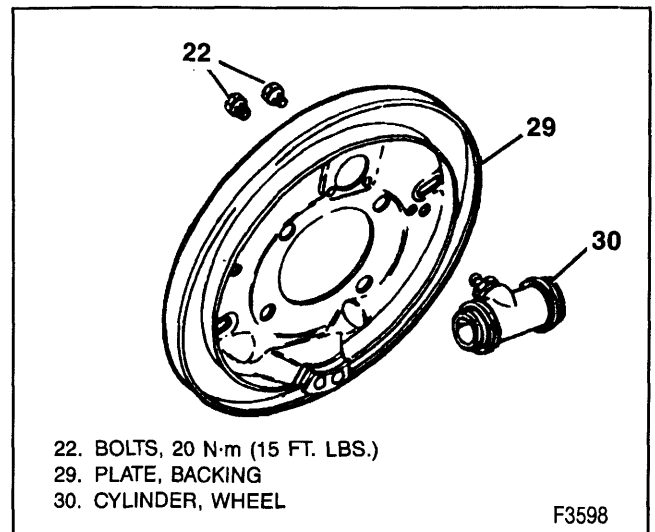


Figure 2—Wheel Cylinder Replacement

5C2-4 DUO-SERVO DRUM BRAKES

1. Linings. Refer to "Linings" in this section.
2. Brake pipe.
3. Bolts (22).
4. Wheel cylinder (30).

Install or Connect (Figure 2)

NOTICE: For steps 2 and 3, refer to "Notice" on page 5C2-1.

1. Wheel cylinder (30).
2. Bolts (22).

Tighten

- Bolts (22) to 20 N.m (15 lbs. ft.).
3. Brake pipe.

Tighten

- Brake pipe fitting to 17 N.m (13 lbs. ft.).
4. Linings. Refer to "Linings" in this section.
 5. Bleed brake system. Refer to SECTION 5.

BACKING PLATE

Remove or Disconnect (Figure 3)

CAUTION: Refer to "Caution" on page 5C2-1.

1. Linings. Refer to "Linings" in this section.
2. Wheel cylinder. Refer to "Wheel Cylinder" in this section.
3. Bolts (31) and washers (32).
4. Backing plate (29).

Install or Connect (Figure 3)

1. Backing plate (29).

NOTICE: Refer to "Notice" on page 5C2-1.

2. Bolts (31) and washers (32).

Tighten

- Bolts (31) to 160 N.m (118 lbs. ft.).
3. Wheel cylinder. Refer to "Wheel Cylinder" in this section.

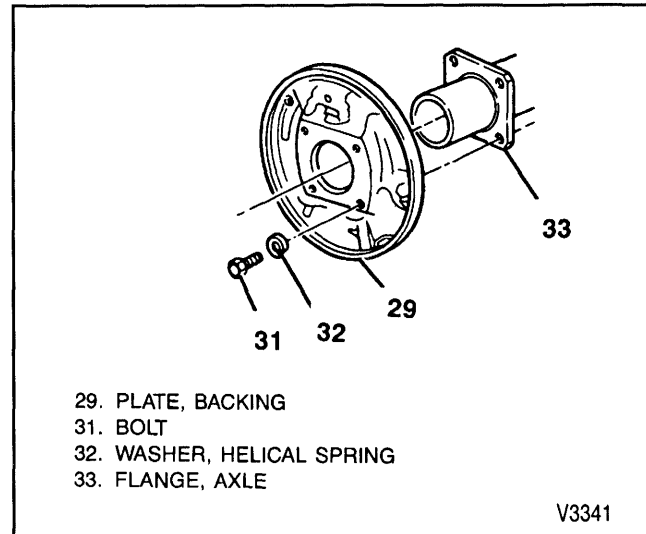


Figure 3—Backing Plate Replacement

4. Linings. Refer to "Linings" in this section.
5. Adjust brakes. Refer to "Adjustment" in this section.
6. Bleed brake system. Refer to SECTION 5.

ADJUSTMENT

CAUTION: Refer to "Caution" on page 5C2-1.

Adjust

1. Remove the adjusting hole cover in the backing plate.
2. Turn adjusting screw until the wheel can just be turned by hand.
 - The brake drag should be equal at both wheels.
3. Back off the adjusting screw 33 notches.

Important

- Brakes should have no drag after the screw has been backed off about 15 notches. If a heavy drag is present, refer to SECTION 5F.
4. Install an adjusting hole cover in the backing plate.
 5. Check the parking brake adjustment. Refer to SECTION 5F.

PARKING BRAKE ADJUSTMENT

For information on adjusting the parking brake, refer to SECTION 5F.

UNIT REPAIR

DRUMS

CRACKED, SCORED, OR GROOVED

A cracked drum is unsafe for further service and must be replaced. Do not attempt to weld a cracked drum.

Smooth up any slight scores. Heavy or extensive scoring will cause excessive lining wear, and it may be necessary to resurface the drum braking surface.

If the linings are slightly worn (but still reusable) and the drum is grooved, polish the drum with fine emery cloth but do not refinish. Eliminating all grooves in the drum and smoothing the ridges on the lining would require removing too much metal and lining. If left alone, the grooves and ridges match and satisfactory service can be obtained.

If you are replacing the brake linings, always refinish a grooved drum. Using a grooved drum with new linings will wear the linings and make proper brake performance difficult to obtain.

OUT-OF-ROUND OR TAPERED

An out-of-round or tapered drum prevents accurate brake shoe adjustment and is likely to cause excessive wear of other brake parts due to its eccentric action. An out-of-round drum can also cause severe and irregular tire tread wear as well as a pulsating brake pedal. When the drum exceeds the specification limits in taper and/or out-of-round, refinish the drum to true up the braking surface. Out-of-round and taper can be accurately measured with an inside micrometer and extension rods.

When measuring a drum for out-of-round and taper, take measurements at the open and closed edges of the machined surface and at right angles to each other.

REFINISHING

If you determine a drum needs refinishing, remove only enough metal to obtain a true, smooth braking surface. If a drum does not clean up when refinished to the maximum refinish diameter, as shown in "Specifications" at the end of this section, replace it. Removal of more metal will affect heat dissipation and can cause drum distortion.

All brake drums have a maximum diameter cast into them. This diameter is the maximum wear diameter and not a refinish diameter. Do not refinish a brake drum that will not meet the "Specifications" at the end of this section; instead, replace it.

When you refinish a brake drum, resurface the drum to a dimension no more than 0.76 mm (0.030 inch) less than the discard diameter. The refinish diameter is the maximum diameter the drum can be refinished to and still allow safe braking action. If you exceed this diameter, the brake drum will wear beyond the discard diameter during normal brake use.

Always use sharp cutting tools or bits. Dull or worn tools leave a poor surface finish that will affect initial braking performance. Always use vibration dampening attachments when you refinish braking surfaces. These attachments eliminate tool chatter so you can obtain a better surface finish.

The best speed for refinishing braking surfaces is a spindle speed of 150 rpm. Crossfeed for rough cutting should range from 0.15 to 0.25 mm (0.006 to 0.010 inch) per revolution. Finish cuts should be made at crossfeeds no greater than 0.05 mm (0.002 inch) per revolution.

New Replacement Drum Refinishing

When installing new brake drums, do not refinish the braking surface. These parts are already at the correct level of surface finish.

BALANCE

During manufacturing, weights are used to balance brake drums. Do not remove these weights.

After you refinish brake drums, or when maintaining wheel balance is difficult, check the drums for balance. They can be checked on most off-vehicle balancers. If found to be out of balance, replace the drum.

WHEEL CYLINDER

Remove or Disconnect (Figure 4)

1. Bleeder valve (1).
2. Boots (4).
3. Pistons (3).
4. Seals (2).
5. Spring (5).

Inspect

- Cylinder bore for scoring and corrosion.
- Spring assembly for signs of discoloration due to heat. Replace if necessary.

Clean

- Inside the cylinder bore with crocus cloth. If the bore is still scored, replace the cylinder.
- Cylinder with clean brake fluid.

Install or Connect (Figure 4)

1. Lubricate the seals and cylinder bore with clean brake fluid.
2. Spring (5).
3. Seals (2).
4. Pistons (3).
5. Boots (4).

NOTICE: Refer to "Notice" on page 5C2-1.

6. Bleeder valve (27).

Tighten

- Bleeder valve (27) to 7 N.m (62 lbs. in.)
- 7. Links (21).

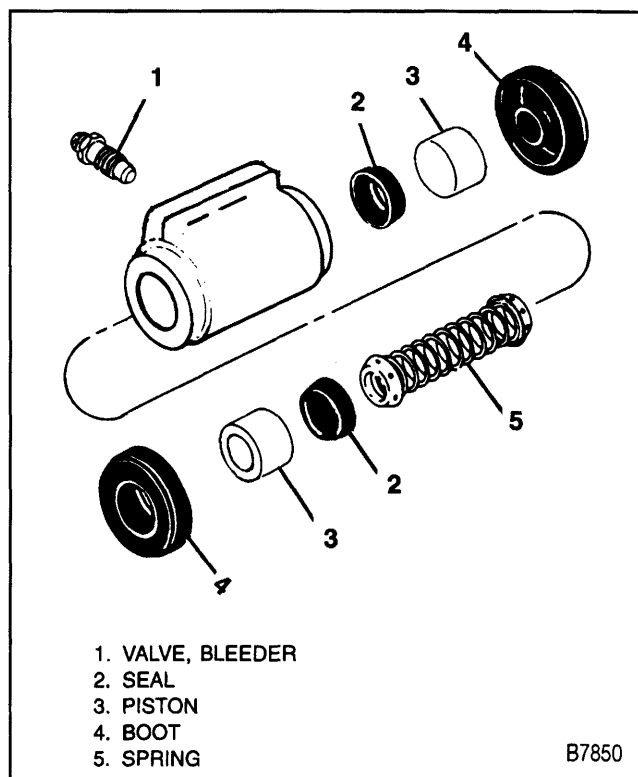


Figure 4—Wheel Cylinder Components

5C2-6 DUO-SERVO DRUM BRAKES

SPECIFICATIONS BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 2.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

DRUM DIAMETERS

ORIGINAL	MAXIMUM (REFINISH)	REPLACEMENT (DISCARD)
254 mm (10 in.)	255.30 mm (10.05 in.)	356.30 (10.09 in.)
283.21 mm (11.15 in.)	284.73 mm (11.21 in.)	285.50 (11.24 in.)
330.20 mm (13 in.)	331.72 mm (13.06 in.)	332.49 (13.09 in.)

T2216

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Lbs. Ft.	Lbs. In.
Anchor Pin (JB5).....	430	317	—
Anchor Pin Nut (JB7, JB8)	310	228	—
Backing Plate Mounting Bolt (JB5).....	55	40	—
Backing Plate Mounting Bolt (JB7, JB8)	160	118	—
Bleeder Valve	7	—	62
Pipe Fitting.....	17	13	—
Wheel Cylinder Mounting Bolt	25	18	—

T2947

SECTION 5D1**VACUUM BOOSTER SYSTEM**

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION**BOOSTER ASSEMBLY**

The vacuum booster is a tandem diaphragm vacuum suspended unit. During normal operation, with the brake pedal released, manifold vacuum is applied to both sides of the diaphragms. Applying the brakes allows air at atmospheric pressure to enter one side of each diaphragm. This pressure difference provides the power assist.

The booster assembly is located on the left front cowl and serves as the mounting surface for the master cylinder.

CHECK VALVE HOSE AND ROUTING

Vacuum is supplied to the booster by a pipe located on the left side of the intake manifold. A flexible hose connects the pipe to the booster check valve. The check valve is mounted in a grommet on the front of the booster assembly.

5D1-2 VACUUM BOOSTER SYSTEM

DIAGNOSIS OF THE VACUUM BOOSTER

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hard Pedal	1. Broken or damaged hydraulic brake pipes and hoses. 2. Faulty vacuum check valve or grommet. 3. Collapsed or damaged vacuum hose. 4. Plugged or loose vacuum fitting. 5. Faulty air valve seal or support plate. 6. Damaged floating control valve. 7. Bad stud welds on front or rear housing or power head. 8. Faulty booster diaphragm. 9. Restricted air filter element. 10. Worn or distorted reaction plate or levers. 11. Cracked or broken power pistons or retainer.	1. Inspect and replace as necessary. 2. Replace. 3. Replace hose. 4. Clean or tighten. 5. Replace. Refer to the Light Duty Truck Unit Repair Manual. 6. Replace. Refer to the Light Duty Truck Unit Repair Manual. 7. Replace unless easily repaired. 8. Replace. Refer to the Light Duty Truck Unit Repair Manual. 9. Replace. 10. Replace plate or levers. Refer to the Light Duty Truck Unit Repair Manual. 11. Replace power pistons and piston rod retainer. Refer to the Light Duty Truck Unit Repair Manual.
Grabby Brakes (Apparent Off-On Condition)	1. Broken or damaged hydraulic brake pipes and hoses. 2. Low fluid level in the master cylinder. 3. Faulty master cylinder seals. 4. Cracked master cylinder casing. 5. Leaks in front calipers or rear wheel cylinders or in pipes or connections. 6. Air in hydraulic system.	1. Inspect and replace as necessary. 2. Fill reservoirs with proper brake fluid. Check for leaks. 3. Repair or replace as necessary. 4. Replace. 5. Inspect and repair as necessary. 6. Bleed system.
Brakes Fail to Release	1. Blocked passage in power piston. 2. Air valve sticking shut. 3. Broken piston return spring or air valve spring. 4. Tight brake pedal linkage. 5. Misadjusted stoplamp or cruise control switches.	1. Inspect and repair or replace as necessary. Refer to the Light Duty Truck Unit Repair Manual. 2. Check for proper lubrication of air valve O-ring seal. Refer to the Light Duty Truck Unit Repair Manual. 3. Replace. Refer to the Light Duty Truck Unit Repair Manual. 4. Repair or replace as necessary. 5. Readjust switches.

D0106

ON-VEHICLE SERVICE

BOOSTER ASSEMBLY

**Remove or Disconnect (Figures 1 and 2)**

1. Apply parking brake.
2. Nuts (1).
3. Master cylinder (4) and combination valve bracket (as used).
 - Support the master cylinder.
4. Vacuum hose.
5. Retainer (13) and washer (14).
6. Pushrod (6).

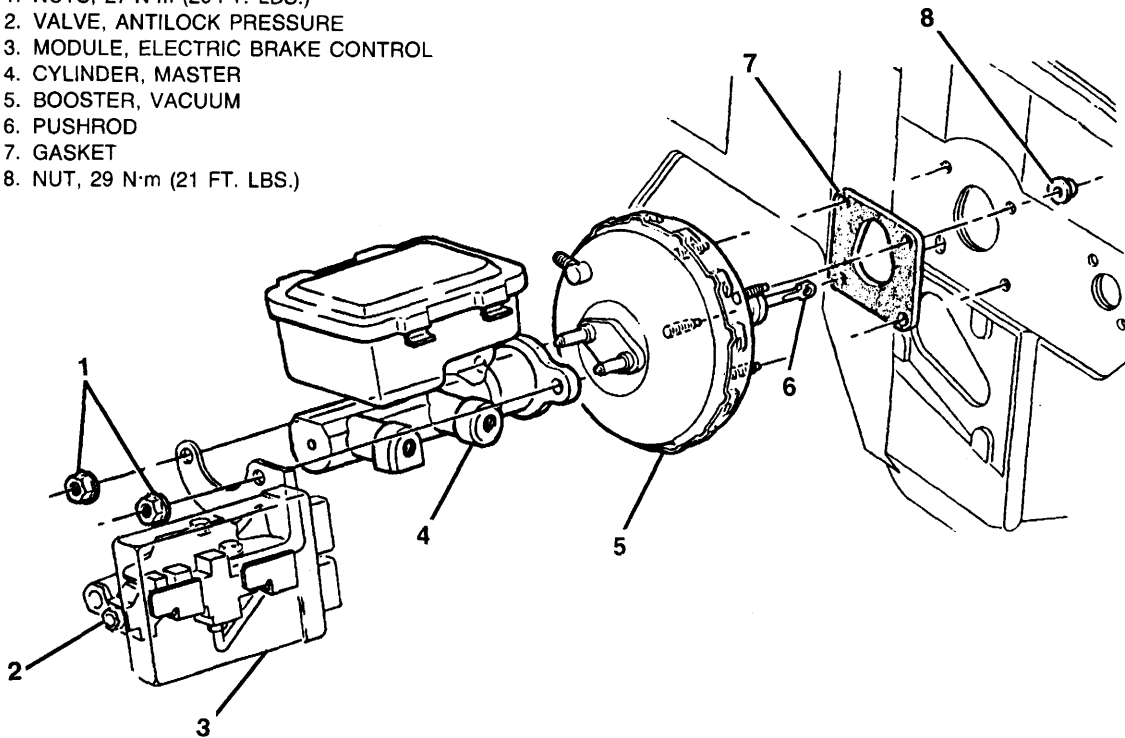
7. Nuts (8).
8. Booster assembly (5).
9. Gasket (7).

**Install or Connect (Figures 1 and 2)**

NOTICE: For steps 3 and 8, refer to "Notice" on page 5D1-1.

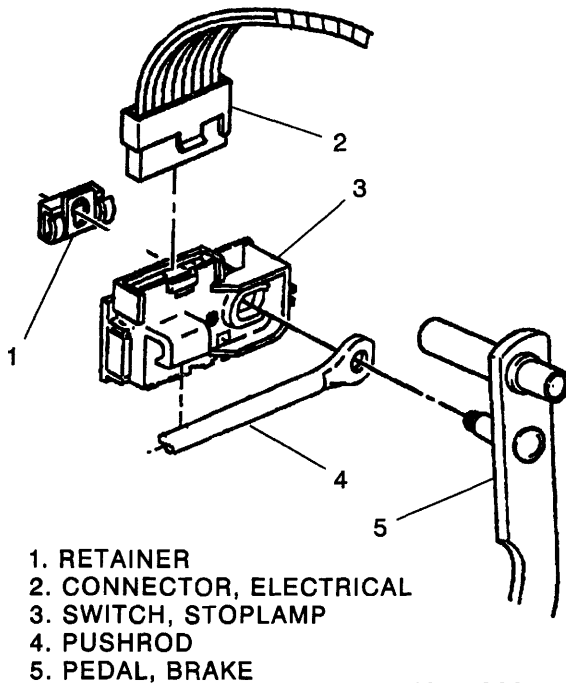
1. Gasket (7).
2. Booster assembly (5).

1. NUTS, 27 N·m (20 FT. LBS.)
2. VALVE, ANTILOCK PRESSURE
3. MODULE, ELECTRIC BRAKE CONTROL
4. CYLINDER, MASTER
5. BOOSTER, VACUUM
6. PUSHROD
7. GASKET
8. NUT, 29 N·m (21 FT. LBS.)



F3525

Figure 1—Vacuum Booster



1. RETAINER
2. CONNECTOR, ELECTRICAL
3. SWITCH, STOPLAMP
4. PUSHROD
5. PEDAL, BRAKE

3105r4322

Figure 2—Booster Pushrod

3. Nuts (8).



Tighten

- Nuts (8) to 29 N·m (21 lbs. ft.).
4. Pushrod (6).
 5. Washer (14) and retainer (13).
 6. Vacuum hose.



Measure

- Gage the booster pushrod. Refer to "Gaging Procedure" in this section.
7. Master cylinder (4) and combination valve bracket (as used).
 8. Nuts (1).



Tighten

- Nuts (1) to 27 N·m (20 lbs. ft.).
9. Release parking brake.

GAGING PROCEDURE

Tool Required:

J 37839 Pushrod Height Gage

1. Gage the piston rod using J 37839 (figure 3).
 - A. Gage the booster with 85.0 kPa (25 in. Hg) vacuum or maximum engine vacuum.
 - B. Check maximum and minimum rod lengths.
2. If the piston rod is not within limits, obtain a service adjustable piston rod and adjust the rod to the correct measurement.

5D1-4 VACUUM BOOSTER SYSTEM

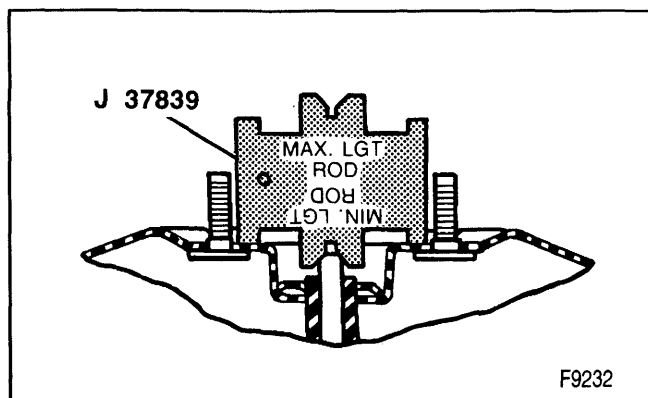


Figure 3—Gaging the Piston Rod

CHECK VALVE HOSE AND ROUTING

Vacuum hose routing is shown in figure 4.

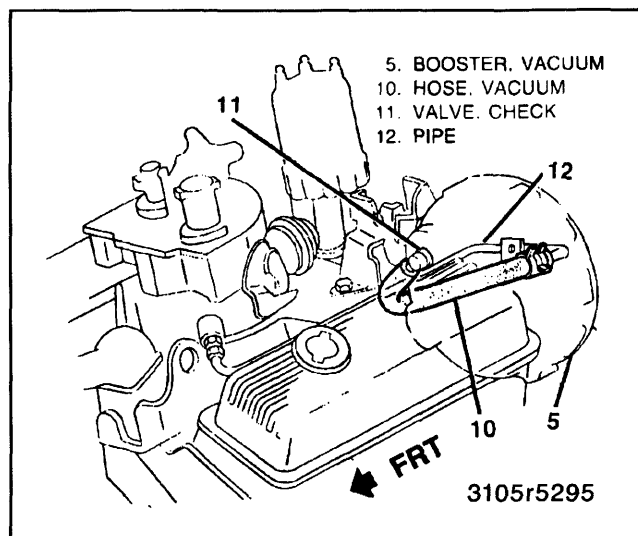


Figure 4—Vacuum Hose Routing

SPECIFICATIONS

BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

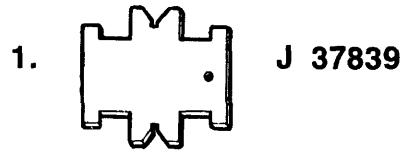
T2112

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Ft. Lbs.
Booster Mounting Nuts	29	21
Master Cylinder Mounting Nuts	27	20

T2744

SPECIAL TOOLS



1. Power Brake Push Rod Height Gage

V1377

5D1-6 VACUUM BOOSTER SYSTEM

NOTES

SECTION 5D2

HYDRAULIC BOOSTER SYSTEM

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION**BOOSTER ASSEMBLY**

Some C/K Models use a hydraulic booster to provide power assist (figure 1). The hydraulic booster uses fluid pressure from the power steering pump to provide the power assist. The booster assembly is located on the left front cowl and serves as the mounting surface for the master cylinder.

POWER STEERING PUMP

The power steering pump supplies hydraulic pressure to operate the brake booster. The pump is belt driven and mounts to the engine. The power steering pump provides a continuous flow of fluid to the booster any time the engine is running.

5D2-2 HYDRAULIC BOOSTER SYSTEM

PIPES, HOSES, AND FITTINGS

Three flexible hoses route the power steering fluid through the hydraulic booster system. One hose supplies pressurized fluid from the power steering pump. Another hose routes pressurized fluid from the booster to the steering gear for the purpose of power steering. The last hose returns fluid to the power steering pump.

FLUID AND FLUID HANDLING

This system uses no special fluids. However, care must be taken to use the correct fluids. The master cylinder and brake systems use brake fluid, while the hydraulic booster uses power steering fluid.

SUBSTANDARD OR CONTAMINATED FLUID

NOTICE: Hydraulic brake systems use two distinct and incompatible fluids. Power steering fluid is used in the hydraulic brake booster system. Brake fluid is used in the master cylinder and brake pipes. Use extreme care when selecting brake system fluids or seal damage can result. Refer to SECTION 0B to select the correct fluid.

Do not reuse brake system fluids. Do not mix power steering fluid with brake fluid. Swelling and deterioration of rubber parts may result from fluid contamination. This can lead to reduced brake performance and the eventual loss of braking capability.

If contamination occurs, flush the hydraulic booster system with clean power steering fluid. Refer to "Flushing the Hydraulic Booster System" in this section.

Booster component bench servicing should be done in a clean work area separate from the brake servicing area. Wash hands before changing between brake and booster work areas. Do not use the same containers for brake and power steering fluids.

FLUSHING THE HYDRAULIC BOOSTER SYSTEM

Flushing is required when the fluid in the power steering/hydraulic booster system becomes contaminated. Contaminated fluid in the booster system can cause rubber deterioration. This involves draining the old fluid and replacing it with clean fluid. For the procedure to flush the system, refer to SECTION 3B.

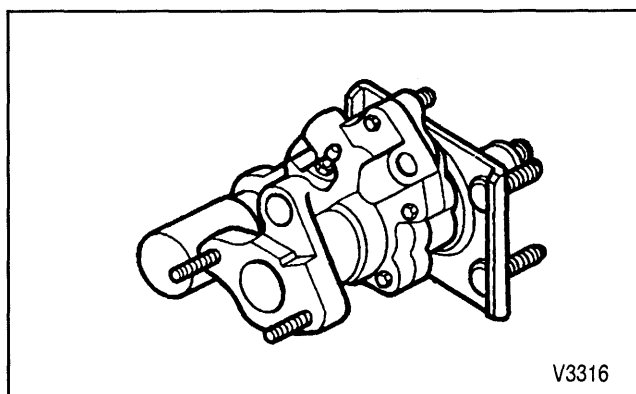


Figure 1—Hydraulic Booster Assembly

DIAGNOSIS OF THE HYDRAULIC BOOSTER SYSTEM

PROBLEM	POSSIBLE CAUSE	CORRECTION
Slow Brake Pedal Return	1. Excessive seal friction in booster. 2. Faulty spool action. 3. Restriction in return hose from booster to pump reservoir. 4. Damaged input rod end.	1. Overhaul with new seal kit. 2. Flush steering system while pumping brake pedal. 3. Replace hose. 4. Replace input rod and piston assembly.
Grabby Brakes-Booster Chatters - Pedal Vibrates	1. Faulty spool action caused by contamination in system. 2. Power steering pump belt slips. 3. Low fluid level in power steering pump.	1. Flush steering system while pumping brake pedal. 2. Refer to SECTION 6B1. 3. Fill reservoir and check for external leaks.
Accumulator Leak-Down System Does Not Hold Charge	1. Contamination in steering or booster system. 2. Internal leakage in accumulator system.	1. Flush steering system while pumping brake pedal. 2. Overhaul unit using accumulator rebuild kit and seal kit.
Brakes Self-Apply When Steering Wheel Turned	1. Contamination in steering or booster system. 2. Restriction in return hose from booster to pump reservoir.	1. Replace hydraulic booster. Flush complete system. 2. Replace hose.

POWER BRAKE UNITS

BENDIX HYDRO-BOOST

TROUBLESHOOTING

HYDRAULIC BRAKE BOOSTERS
PROCEDURE FOR NOISE—SLOW OR INCOMPLETE BRAKE PEDAL
RETURN—OVERSENSITIVE BRAKING—SELF-APPLYING BRAKES

NOISY BRAKE BOOSTER

VERIFY COMPLAINT
1. TYPE OF NOISE.
2. WHEN IT OCCURS.

IF THE NOISE OCCURS DURING
• HIGH BRAKE PEDAL EFFORTS.
• QUICK PEDAL RELEASE

SEE NORMAL OPERATION NOISES AND
COMPARE WITH A KNOWN
ACCEPTABLE SYSTEM

HYDRO-BOOST BRAKE NOISE
CHARACTERISTICS.
NORMAL OPERATING NOISES.

NORMAL HYDRO-BOOST UNITS
PRODUCE CERTAIN CHARACTERISTIC
BOOSTER NOISES. THESE NOISES
OCCUR, FOR THE MOST PART, WHEN
THE BRAKE PEDAL IS MANIPULATED IN
A MANNER NOT ASSOCIATED WITH
EVERYDAY BRAKING OR DRIVING
HABITS. THE GENERAL CATEGORIES
OF NORMAL OPERATING NOISES ARE
(1) HISSING NOISES AND (2)
CLUNK/CLICK/CLATTER NOISES.

THE HYDRO-BOOST WILL EMIT NORMAL
HISSING NOISES WHEN ABOVE
NORMAL BRAKE PEDAL EFFORTS ARE
APPLIED (60 LBS. PEDAL EFFORT AND
UP). THE HISS SOUNDS ARE
PARTICULARLY NOTICEABLE WITH THE
VEHICLE MOTIONLESS AND WILL
INCREASE IN INTENSITY AS PEDAL
PRESSURE INCREASES ABOVE 60 LBS.
AND SYSTEM OPERATING
TEMPERATURE INCREASES. LOUD
HISSING SOUNDS AT OR BELOW
NORMAL (20-25 LBS.) PEDAL EFFORT
WARRANTS INVESTIGATION.

CLUNK, CLATTER, OR CLICKING NOISES
WILL BE HEARD WHEN THE BRAKE
PEDAL IS QUICKLY RELEASED FROM
HARD (50-100 LBS.) PEDAL EFFORTS.

IF THE NOISE OCCURS
DURING:
• LOW BRAKE PEDAL
EFFORT
• ENGINE IDLE—NO
PEDAL EFFORT.
• NORMAL DRIVING
CONDITIONS.

RUN THE ENGINE UNTIL
IT IS AT NORMAL
OPERATING
TEMPERATURE

DUPLICATE THE
OPERATING CONDITION
ABOVE AND LISTEN FOR
THE NOISE.

COMPARE RESULTS WITH
A KNOWN ACCEPTABLE
SYSTEM

ERRATIC OPERATION, STICKS, BINDS, OR GRABS

RUN ENGINE AT FAST IDLE

PULL THE BRAKE PEDAL REARWARD WITH
APPROXIMATELY 10 POUNDS OF FORCE. RELEASE
THE PEDAL AND MEASURE THE DISTANCE TO
THE FLOOR BOARD

MAKE A 100 LB. BRAKE APPLICATION. RELEASE
THE BRAKE PEDAL AND AGAIN MEASURE THE
PEDAL TO FLOOR BOARD DISTANCE. THE PEDAL
SHOULD RETURN TO ITS ORIGINAL POSITION

IF THE PEDAL DOES NOT RETURN PROPERLY,
CHECK THE PEDAL TO BE SURE IT IS OPERATING
FREELY. CORRECT ANY STICKING OR BINDING AS
NECESSARY.

IF BRAKES SELF-APPLY AND PEDAL IS FREE,
CHECK FOR OBSTRUCTION IN THE RETURN LINE
OR KINKED CONNECTIONS BETWEEN HYDRO-
BOOST AND POWER STEERING PUMP RESERVOIR.

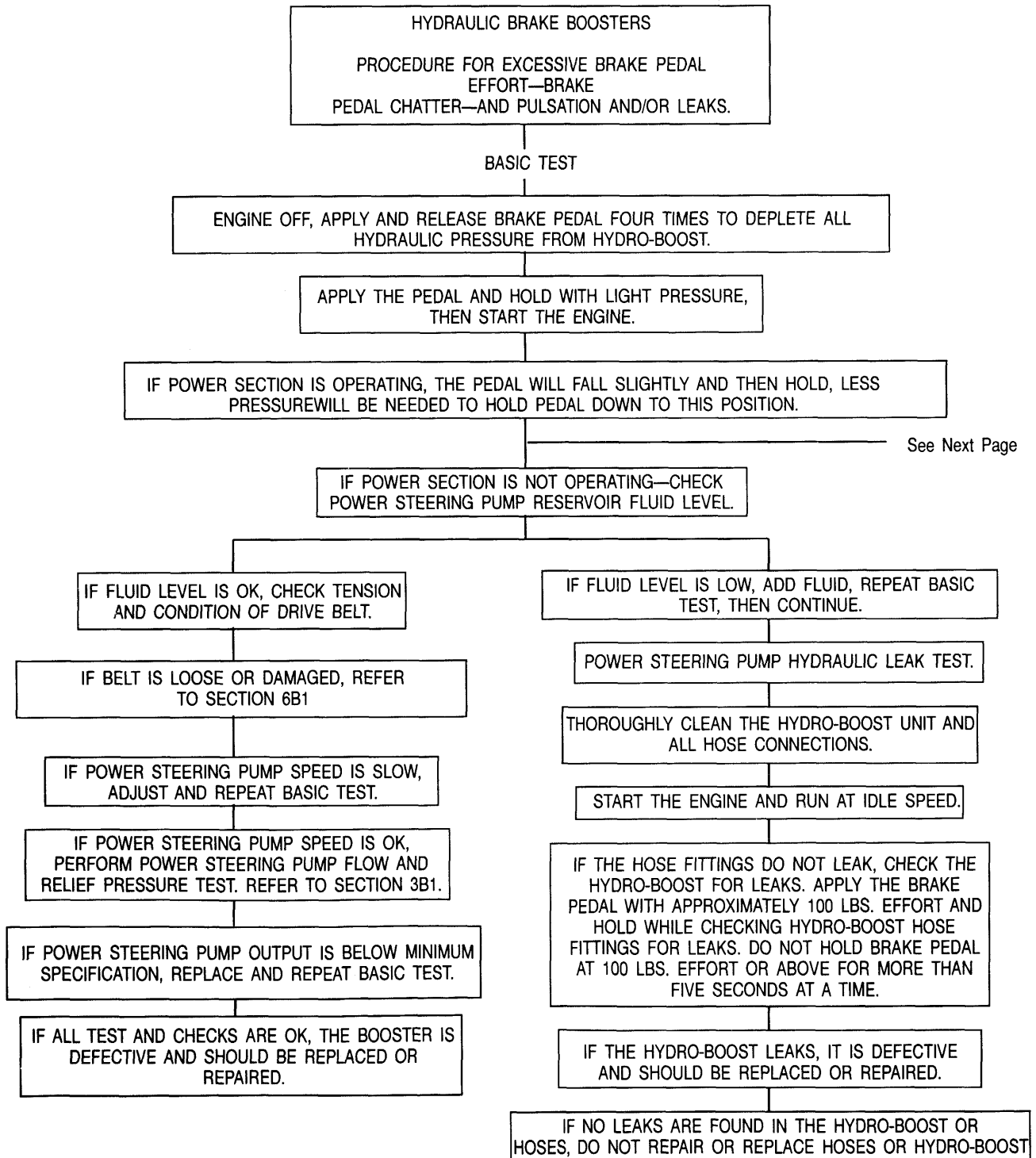
REMOVE OBSTRUCTION OR REPLACE LINE AS
REQUIRED. IF CONDITION REMAINS, CHECK FOR A
DAMAGED REACTION END. IF DAMAGED, HYDRO-
BOOST SHOULD BE REPLACED OR REPAIRED.

IF THE PEDAL IS FREE OF ANY BINDING
CONDITION, AND THERE ARE NO OBSTRUCTIONS
IN THE RETURN HOSE, REMOVE THE MASTER
CYLINDER RESERVOIR COVER.

OBSERVE THE BRAKE FLUID IN THE RESERVOIR
WHILE RAPIDLY APPLYING THE BRAKE PEDAL
ONE INCH.

FLUID SURFACE SHOULD HAVE SOME
MOVEMENT OR SPOUT IN THE FORWARD
RESERVOIR. IF NO MOVEMENT OR SPOUTING
OCCURS, EITHER THE HYDRO-BOOST UNIT IS
DEFECTIVE AND MUST BE REPLACED OR
REPAIRED, OR THE MASTER CYLINDER IS
DEFECTIVE. REFER TO SECTION 5A.

**POWER BRAKE UNITS
BENDIX HYDRO-BOOST (CONT.)
TROUBLE SHOOTING**

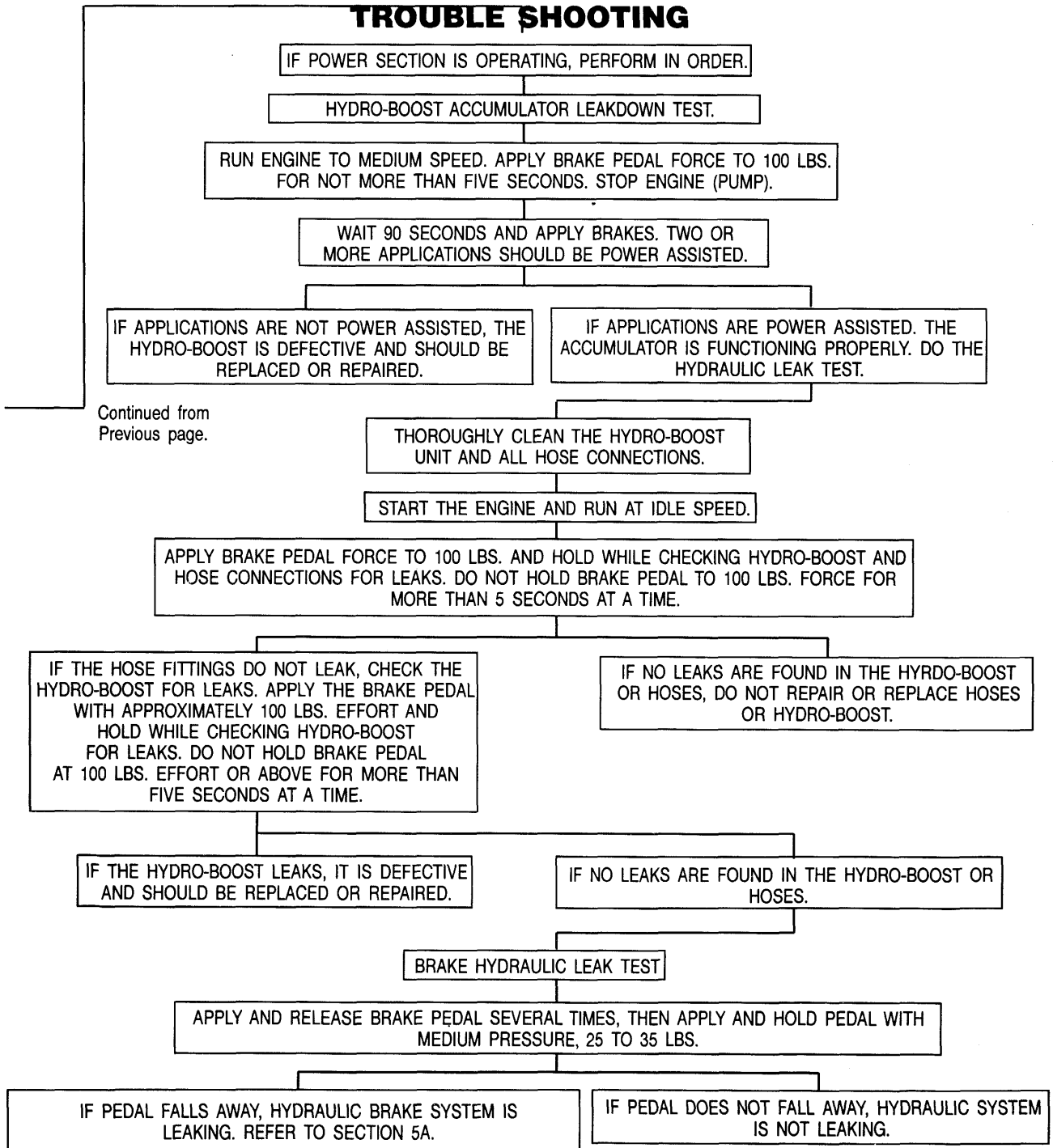


POWER BRAKE UNITS

BENDIX HYDRO-BOOST

(Cont.)

TROUBLE SHOOTING



HYDRAULIC SYSTEM FLUID LOSS

NOTICE: Do not run the engine without fluid in the power steering pump reservoir. Doing so could damage the pump bearings and seals. The belt that drives the power steering pump also drives the coolant pump and other components. Do not disconnect the belt and run the engine. A malfunctioning power steering pump and/or system still serves as an idler pulley for the belt. If the pump is allowed to run without fluid in it, the bearings will seize up and cause the coolant pump to stop. This can cause damage to the engine.

If the hydraulic booster system fails due to a loss of fluid, the following steps should be taken before starting the vehicle.

- If the failed part is not the power steering pump, route the pressure pipe back to the fluid reservoir.
- Make all necessary repairs. Fill and bleed the power steering system. Refer to SECTION 3B.

The hydraulic booster system should be cleaned and flushed when the power steering pump is replaced. Metal shavings from a worn power steering pump often contaminate the system. The booster head should be disassembled, cleaned, and have all seals and O-rings replaced. Pipes and hoses should be removed and blown clean of all metal shavings. Refer to SECTION 3B for information on flushing and "Booster Assembly" in this section.

BELT TENSION

When servicing any part of the brake system, check the power steering pump belt tension and condition. The serpentine belt is not adjustable. Refer to SECTION 6B1.

FLUID LEVEL INSPECTION

When servicing any part of the brake system, check the level in the power steering fluid reservoir. The fluid level in the reservoir should be checked at regular intervals and added as needed. Refer to SECTION 0B.

PIPES, HOSES, AND FITTINGS

All pipes, hoses, and fittings should be inspected for leaks at regular intervals. The fittings must be tight and all clips, clamps, and unions supporting the pipes and hoses must be in place and properly secured. Make sure all hoses and tubes are installed so they do not contact parts of the vehicle that could cause chafing or wear on the hoses.

Check for leaks by wiping the suspected area clean. Leaking fluid can be easily spotted when the suspected area is clean. When fluid leaks appear, tighten, repair, or replace nearby fittings and bolts.

SYSTEM TESTS

The hydraulic booster system works with fluid pressure from the power steering system. Therefore, a malfunctioning power steering system can affect the

booster, just as a booster malfunction can affect the steering system. Before extensive testing, the following checks must be made:

1. Check all the power steering and brake pipe connections for leaks or restrictions.

NOTICE: Power steering fluid and brake fluid cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.

2. Check and fill the master cylinder with brake fluid.
3. Check and fill the power steering pump reservoir with power steering fluid. If the power steering fluid contains air, refer to SECTION 3B for further diagnosis.
4. Check the power steering pump belt for wear and tension. Refer to SECTION 6B1.
5. Check power steering pump pressure. Refer to SECTION 3B.

NOISE DIAGNOSIS

Noise from the relief valve is normal when the brakes are applied. Firmly applying the brake pedal when the vehicle is parked also causes noise. These noises are caused by the air that temporarily gets in the fluid during these conditions. Power steering pump noise can be confused with transmission, rear axle, or generator noise.

The following noises are associated with the hydraulic booster and may or may not be cause for a customer complaint. Some noises are normal and temporary in nature. Other noises can be a sign of wear or air in the hydraulic booster or steering system.

1. A moan or low frequency hum usually accompanied by a vibration in the brake pedal or steering column may be noticed during parking or other low speed maneuvers. This may be caused by a low power steering fluid level or air in the fluid. Holding the power steering pump at relief pressure (steering wheel held all the way in one direction) for more than 5 seconds causes air to enter the system. Check the fluid level and fill as needed. The system must then sit for one hour with the engine off to remove the air. If the condition persists, refer to SECTION 3B for further diagnosis.
2. A high-speed fluid noise may be heard when the brake pedal is applied fully. This condition is normal.
3. A slight hiss may be noticed when the accumulator pressure is used. It is the sound of the hydraulic fluid escaping through the accumulator valve. This condition is normal.
4. If the accumulator is empty and the engine is started, another hissing sound may be heard during the first brake application or steering maneuver. This is caused by fluid rushing through the accumulator charging orifice. It is normal and should only be heard once after the accumulator is emptied. If this sound continues, even though no apparent accumulator pressure assist was made, it could be an indication that the accumulator is not holding pressure and should be checked. Refer to the "Accumulator Leakdown Test" in this section.

FUNCTIONAL TEST

With the ignition switch in the "OFF" position, apply the brake pedal several times to empty the accumulator. Apply the brake pedal using 180 N (40 lbs.) of force and start the engine. The pedal should fall away and then push back against your foot.

ACCUMULATOR LEAKDOWN TEST

1. Start the engine and charge the accumulator by applying the brake pedal or turning the steering wheel from stop to stop.
2. Turn the engine off and let the vehicle sit for one hour.
3. After one hour there should be at least two power assisted applications with the engine off.
4. If the accumulator will not hold a charge for one hour, but functions normally after charging, the accumulator valves are the cause.

- To repair this condition, the booster must be disassembled and the accumulator valves replaced. Refer to the Light Duty Truck Unit Repair Manual.

5. If the accumulator can be heard charging and discharging, but it does not hold a charge, the accumulator valves are the cause.

- To repair this condition, the booster must be disassembled and the accumulator valves replaced. Refer to the Light Duty Truck Unit Repair Manual.

6. Empty the accumulator by pressing the brake pedal several times.
7. If the accumulator has lost its gas charge, the accumulator can will rotate or wobble. Repairing this requires replacing the accumulator assembly.

SEAL LEAK DIAGNOSIS

Refer to figure 2.

- A. INPUT ROD SEAL** A damaged input rod seal will show as a fluid leak from the mounting bracket vent hole. The booster must be removed and disassembled. Check the input rod bore for any scratches that may cause the leak. If scratches are present, the housing cover must be replaced. If no excessive scratches are present, replace all seals using the booster seal kit.
- B. POWER PISTON SEAL** Power piston seal damage is noticed by fluid leaking at the common master cylinder brake booster vent and a possible reduc-

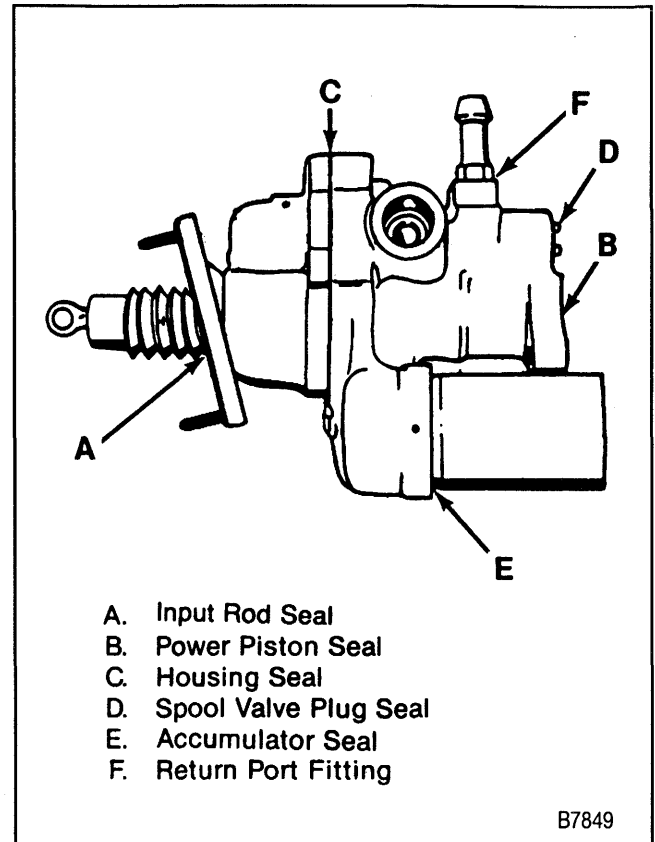


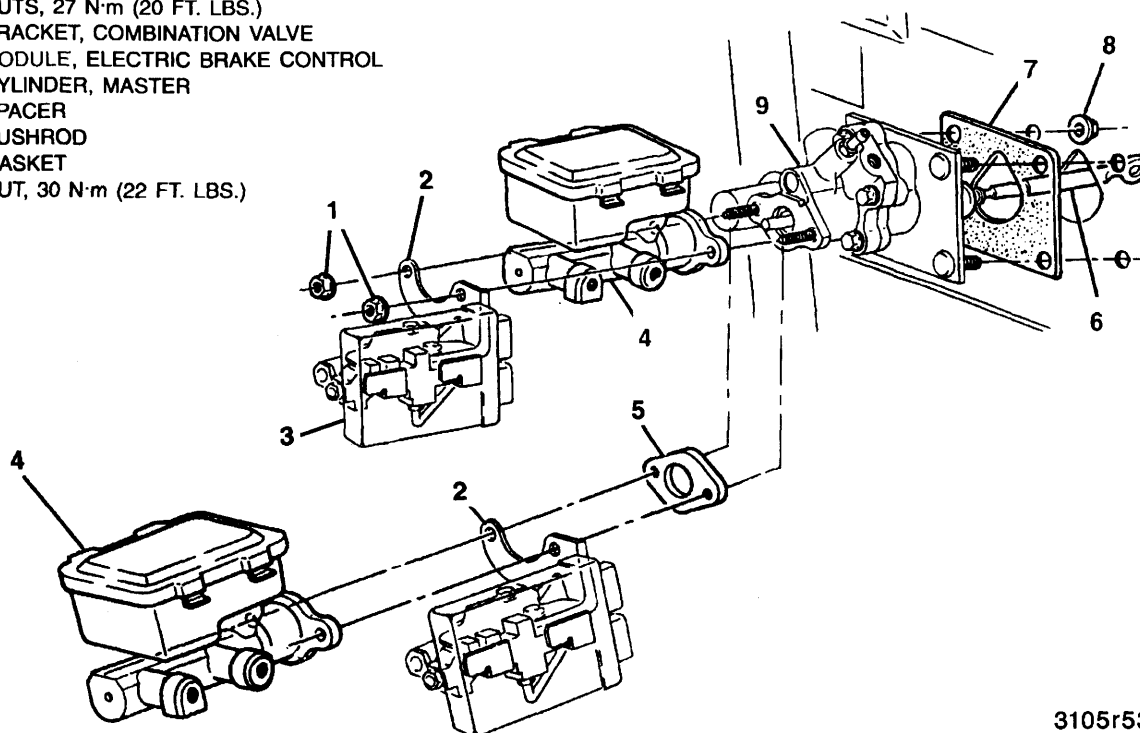
Figure 2—Seal Leak Diagnosis

tion in power assist. The booster must be removed and disassembled. Check the piston for any scratches that may be the cause of the leak. If no scratches are present, replace all seals using the booster seal kit.

- C. HOUSING SEAL** If the housing seal is damaged, fluid will leak between the two housings. The booster must be removed and disassembled. The booster seal kit should be used to replace the housing, input rod, and power piston seals.
- D. SPOOL VALVE PLUG SEAL** Damage to this seal causes fluid to leak past the plug. This seal can be replaced with the booster on the vehicle.
- E. ACCUMULATOR SEAL** Damage to this seal causes fluid to leak past the accumulator cap. This seal can be replaced with the booster on the vehicle.
- F. RETURN PORT FITTING** Tighten the fitting to 10 N.m (88 lbs. in.). If the leak continues, replace the seal ring under the fitting.

5D2-8 HYDRAULIC BOOSTER SYSTEM

1. NUTS, 27 N·m (20 FT. LBS.)
2. BRACKET, COMBINATION VALVE
3. MODULE, ELECTRIC BRAKE CONTROL
4. CYLINDER, MASTER
5. SPACER
6. PUSHROD
7. GASKET
8. NUT, 30 N·m (22 FT. LBS.)



3105r5353

Figure 3—Booster Replacement

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

NOTICE: Hydraulic brake systems use two distinct and incompatible fluids. Power steering fluid is used in the hydraulic brake booster system. Brake fluid is used in the master cylinder and brake pipes. Use extreme care when selecting brake system fluids or seal damage can result. Refer to SECTION 0B to select the correct fluid.

CHECKING AND ADDING FLUID

For information on checking and adding fluid to the hydraulic booster system, refer to SECTION 3B.

BLEEDING THE HYDRAULIC BOOSTER SYSTEM

Refer to the bleeding procedure in SECTION 3B.

FLUSHING THE HYDRAULIC BOOSTER SYSTEM

Refer to the flushing procedures in SECTION 3B.

PIPES, HOSES, AND FITTINGS

For on-vehicle service, refer to SECTION 3B.

BOOSTER ASSEMBLY



Remove or Disconnect (Figures 3, 4, and 5)

1. Apply parking brake.
2. Inlet (10), steering gear (11), and return (12) hoses.
3. Nuts (1).
4. Combination valve bracket (2) and master cylinder (2).
 - Support the master cylinder.
5. Retainer (13) and washer (14).
6. Pushrod (6).
7. Nuts (8).
8. Booster assembly (9).
9. Gasket (7).



Install or Connect (Figures 3, 4, and 5)

NOTICE: For steps 3, 7, and 8, refer to "Notice" on page 5D2-1.

1. Gasket (7).
2. Booster assembly (9).
3. Nuts (4).



Tighten

- Nuts (4) to 30 N·m (22 lbs. ft.).

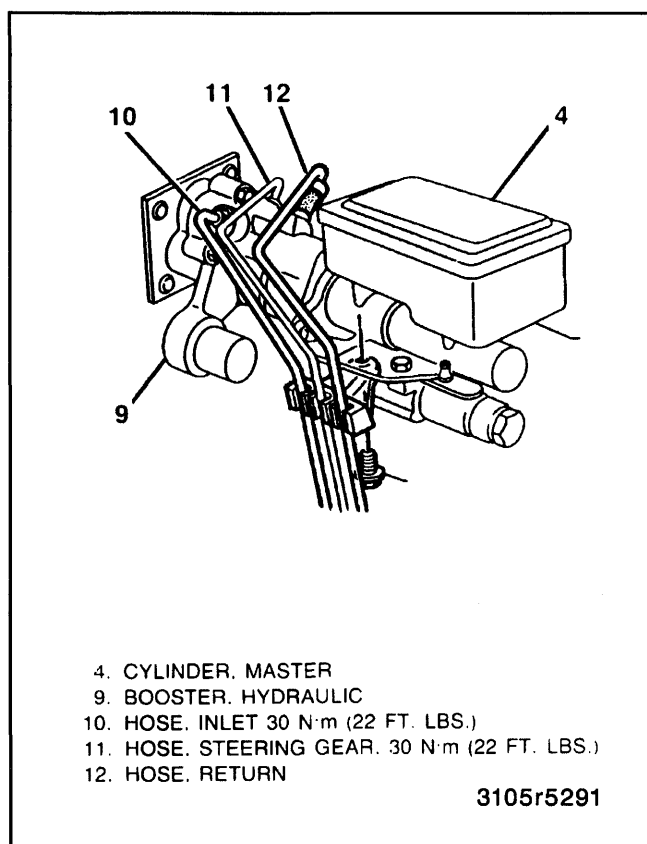


Figure 4—Booster Hoses

4. Pushrod (6).
5. Washer (14) and retainer (13).
6. Master cylinder (4) and combination valve bracket (2).
7. Nuts (1).

 **Tighten**

- Nuts (1) to 27 N·m (20 lbs. ft.).
8. Return (12), steering gear (11), and inlet (10) hoses.

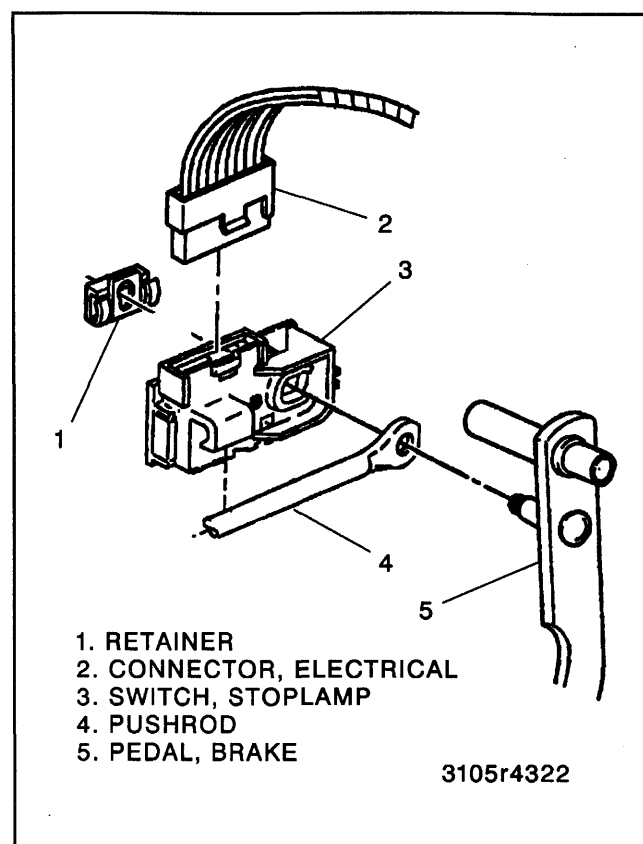


Figure 5—Pushrod Mounting

 **Tighten**

- Hose fittings to 30 N·m (22 lbs. ft.)
9. Bleed booster. Refer to SECTION 3B.

POWER STEERING PUMP

For power steering pump on-vehicle service, refer to SECTION 3B.

5D2-10 HYDRAULIC BOOSTER SYSTEM

SPECIFICATIONS

BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

POWER STEERING FLUID RECOMMENDATIONS

Power Steering Fluid Requirements (All Vehicles)..... GM Power Steering Fluid
(Part No. 1050017) or equivalent

T2644

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Ft. Lbs.
Booster Mounting Nuts	30	22
Hose Fittings	30	22
Master Cylinder Mounting Nuts	27	20

T2945

SECTION 5E1

FOUR WHEEL ANTILOCK BRAKE SYSTEM

CAUTION: When servicing wheel brake parts, do not create dust by grinding or sanding brake linings or by cleaning wheel brake parts with a dry brush or with compressed air. Many earlier model or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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5E1-2 FOUR WHEEL ANTILOCK BRAKE SYSTEM

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GENERAL DESCRIPTION

This section covers diagnostic and service procedures for the four wheel antilock brake system (4WAL). These models use the three sensor 4WAL system. Speed information is obtained using a wheel speed sensor (WSS) at each front wheel and the vehicle speed sensor (VSS) for rear wheel speed information. 4WAL reduces the occurrence of wheel lockup during severe brake applications. The system does this by regulating hydraulic pressure to all four wheels. The pressure is regulated by the brake pressure modulator valve (BPMV) located on the left inner fender (figure 1).

ABBREVIATIONS/DEFINITIONS

BPMV	Brake Pressure Modulator Valve
CKT	Circuit
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DVM	Digital Volt Meter
4WAL	Four Wheel Antilock
4WD	Four Wheel Drive
PWM	Pulse-Width Modulation
2WD	Two Wheel Drive
VSS	Vehicle Speed Sensor
WSS	Wheel Speed Sensor

BASIC KNOWLEDGE REQUIRED

Diagnosing the 4WAL system requires a good understanding of electrical system basics and the use of circuit testing tools. Without this basic knowledge you will find it difficult to use the diagnostic procedures detailed in this section.

Some electrical basics, basic troubleshooting procedures and hints, and the use of circuit testing tools are discussed in the Driveability, Emissions, and Electrical Diagnosis Manual. You will need to know:

• BASIC ELECTRICAL CIRCUITS

- The basic theory of electricity, series and parallel circuits, and voltage drops across series and parallel resistor systems.
- The meaning of volts (voltage), amps (current), and ohms (resistance).

- What happens in a circuit with an open wire or a wire shorted to ground or battery.
- How to read and understand a wiring diagram.

• USE OF CIRCUIT TESTING TOOLS

- How to use a digital volt meter (DVM) to measure voltage, current, and resistance.
- Be aware that when DVM use is requested, the first terminal listed in the check is intended to be connected to the positive (usually red) DVM lead.
- The operation and capabilities of the Tech 1 scan tool and the RWAL/4WAL cartridge used with it.
- How to use jumper wires to test circuits.

SYSTEM OPERATION

The brake pressure modulator valve (BPMV) receives input signals from the vehicle speed sensor (VSS) calibrator for the rear wheels, wheel speed sensors (WSS) located at each front wheel, brake switch, and transfer case switch on 4WD models.

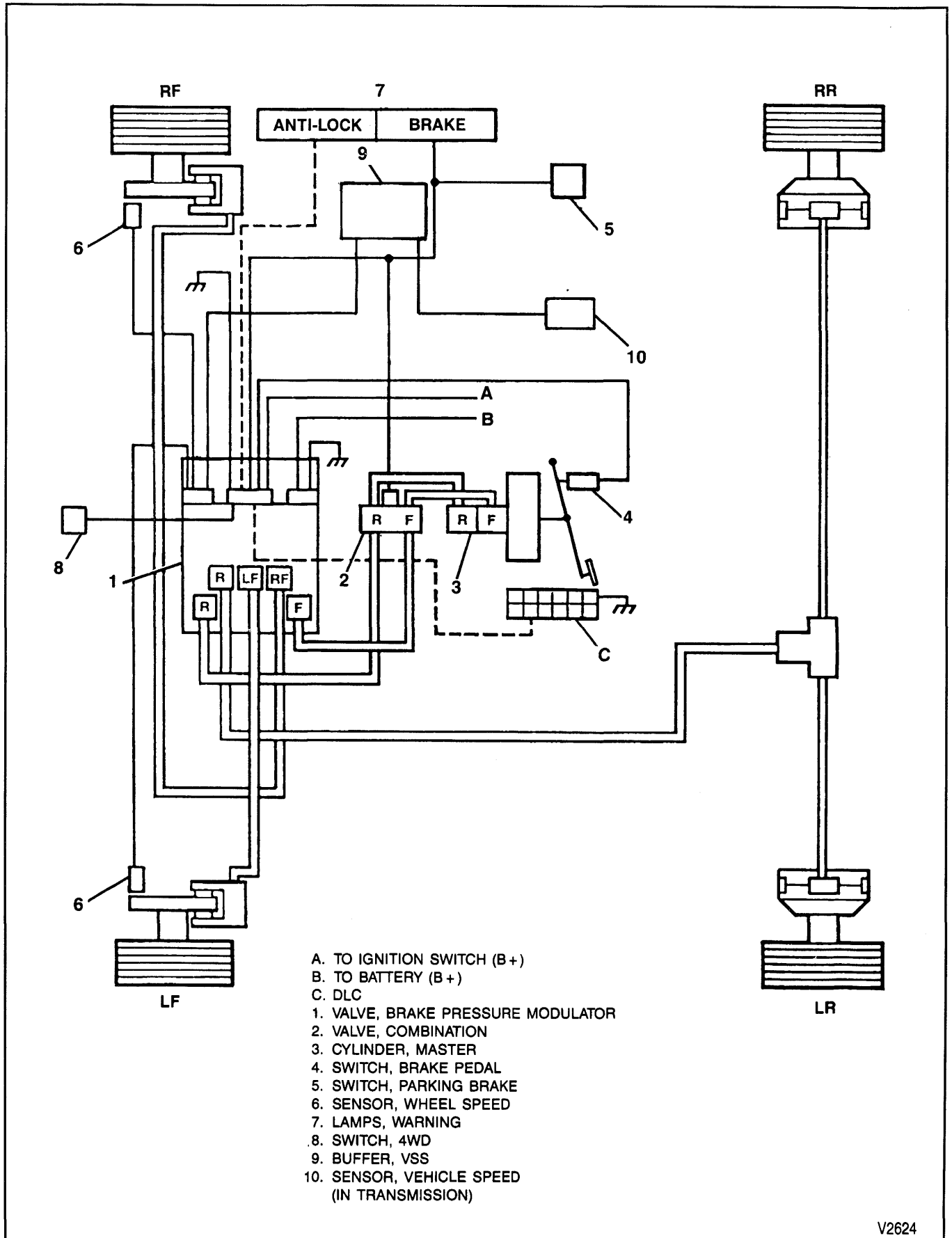
BASE BRAKING MODE

Applying the brake pedal causes the brake switch to open the circuit to the BPMV. When the BPMV loses the signal from the brake switch, it begins to monitor the signals from the VSS calibrator and WSSs for a departure from vehicle speed. It remains in this standby mode until it sees one speed signal indicating a lockup condition or the brake switch indicates braking has stopped. The BPMV does not affect the front or rear brake hydraulic channels at this time.

ANTILOCK BRAKING MODE

When the BPMV sees a change in the speed signals that indicate one or more wheels is locking up, it takes control of the hydraulic channel to the affected wheel(s). The system has the ability to quickly control hydraulic pressure to the left front and right front wheels independently and the rear wheels together. It cycles the solenoids for the affected wheel to maintain, decrease, or increase hydraulic pressure until the speed signal stabilizes with the other speed inputs.

FOUR WHEEL ANTILOCK BRAKE SYSTEM 5E1-3



V2624

Figure 1—Four Wheel Antilock Brake System

5E1-4 FOUR WHEEL ANTILOCK BRAKE SYSTEM

Brake pedal pulsation and occasional tire “chirping” are normal during an antilock stop. The road surface and severity of the braking maneuver determine how much these will occur.

System Self-Test

The first time the vehicle speed reaches approximately 12.9 km/h (8 mph) after an ignition cycle, the BPMV performs a system self-test. It checks its internal and external circuit and performs a function test by cycling the pump motor, isolation solenoids, and PWM solenoids. During this self-test some noise may be heard from the area of the BPMV. This is normal during the self-test cycle. The BPMV then begins its normal operation if no malfunctions are detected.

TIRES AND 4WAL

Spare Tire

Using the spare tire supplied with the vehicle will not affect the performance of the 4WAL system.

Replacement Tires

Replacement tires should be the same size, load range, and construction on all four wheels. Failure to comply with this can affect the performance of the 4WAL system.

Speedometer Calibration

The vehicle speed sensor (VSS) calibrator, must be replaced when the rear axle ratio or tire size is changed. For additional information, refer to SECTION 8C.

WARNING/INDICATOR LAMP OPERATION

The 4WAL system uses an “ANTILOCK” indicator lamp in the instrument panel to show system operation and malfunctions. Should a malfunction occur in the “ANTILOCK” lamp circuit, the “BRAKE” warning lamp serves as a back up.

Normal Lamp Operation

A bulb check occurs each time the ignition switch is turned to the “ON” position. The “ANTILOCK” and “BRAKE” lamps should light, remain on for about two seconds, then turn off. The “ANTILOCK” lamp also indicates 4WAL system malfunctions. When the BPMV detects a malfunction in the system, it turns the “ANTILOCK” lamp on. The lamp may remain on or turn back off depending on the malfunction. To determine the specific cause of the malfunction, refer to “Functional Test.”

SYSTEM COMPONENTS

BRAKE PRESSURE MODULATOR VALVE

The brake pressure modulator valve (BPMV) is located on the left inner fender and regulates hydraulic pressure in the brake system during an antilock stop (figure 2).

The BPMV is split into three hydraulic channels; right front, left front, and rear brakes. Each channel has an isolation valve, pulse-width modulation (PWM) valve, and reset switch. The isolation valves maintain pressure and the PWM valves reduce or increase pressure to each front wheel separately and the rear wheels combined. These valves are controlled by a microprocessor in the BPMV. During a severe brake application, the

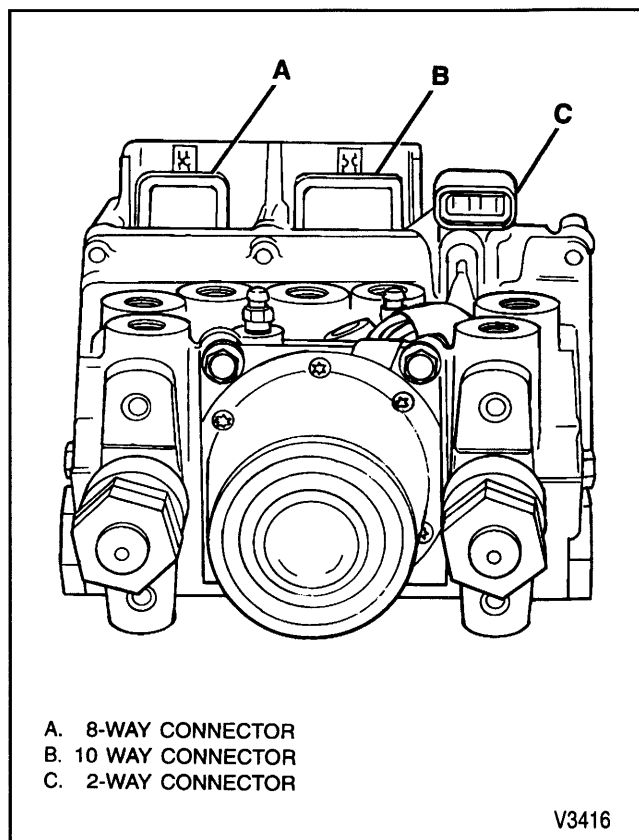


Figure 2—Brake Pressure Modulator Valve

BPMV operates the valves to do one of three functions or a combination of all three. The BPMV allows the valves to either maintain, reduce, or increase hydraulic pressure. The BPMV has low pressure and high pressure accumulators. The low pressure accumulators temporarily store the fluid relieved during the pressure decrease cycle. The high pressure accumulators store fluid under pressure from the pump for use during the pressure increase cycle. The high pressure accumulator fills when the module in the BPMV commands the pump to turn on during an antilock stop.

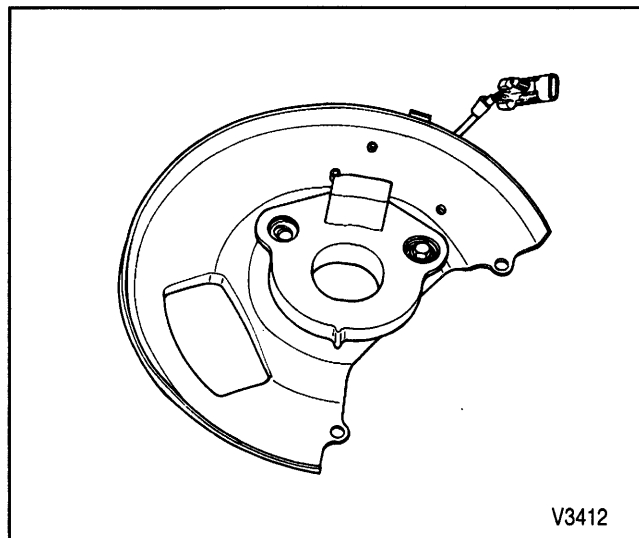


Figure 3—Front Wheel Speed Sensor (2WD)

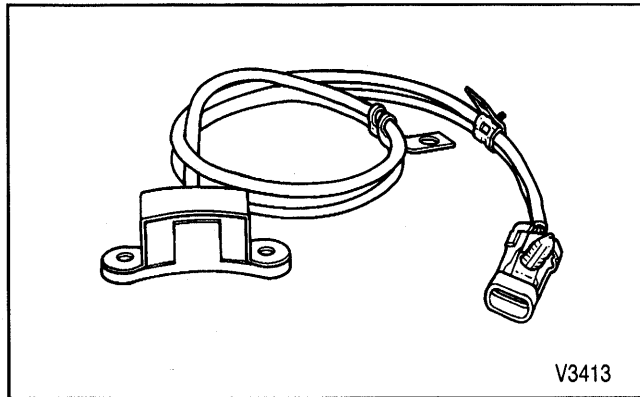


Figure 4—Front Wheel Speed Sensor (4WD)

FRONT WHEEL SPEED SENSOR

The front wheel speed sensor (WSS) is a magnetic/coil pickup that mounts to the front steering knuckle (figures 3 and 4). It produces an AC voltage signal to tell the BPMV how fast the wheel is turning. The faster the wheel turns, the greater the frequency of pulses the sensor produces. The WSSs connect to the BPMV through the 8-pin connector. On 2WD models, the WSSs mount to the dust shields. On 4WD models, the WSSs are separate from the dust shield and are located on the inboard side of the steering knuckle.

FRONT WHEEL SPEED SENSOR TONE WHEELS

The front WSSs use tone wheels to produce an AC voltage signal. Tone wheels are metal rings with teeth on the outside diameter. The AC voltage is produced as

the teeth come into and leave alignment with the sensor. The tone wheels are attached to the rotor on 2WD models and the front drive axle assembly on 4WD models.

VEHICLE SPEED SENSOR

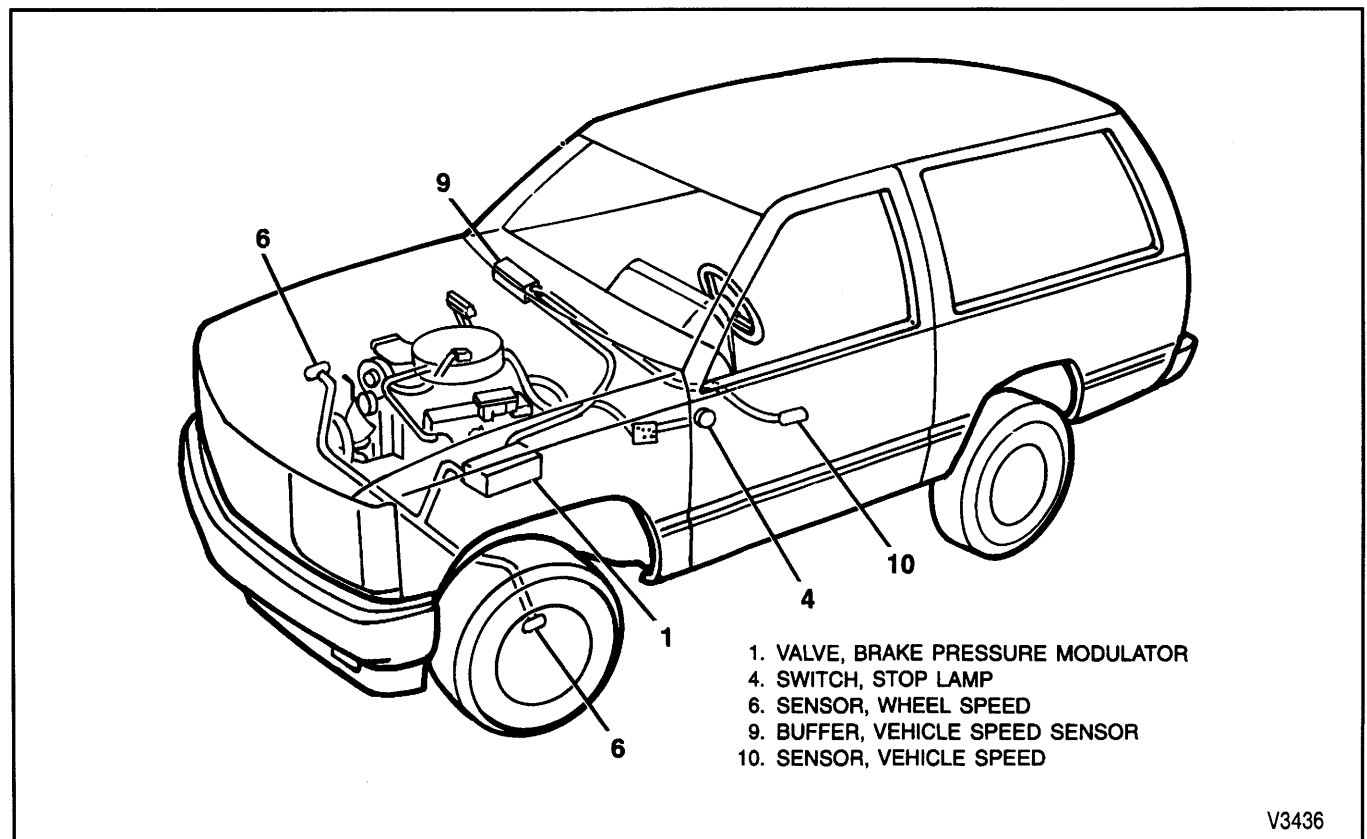
The vehicle speed sensor (VSS) is located in the left rear of the transmission on 2WD models and the transfer case for 4WD models. The VSS produces an AC voltage signal that varies in frequency according to output shaft speed. The resistance value of the VSS winding should be 900 to 2000 ohms.

VEHICLE SPEED SENSOR CALIBRATOR

The VSS sends its signal to the vehicle speed sensor (VSS) calibrator located behind the instrument panel storage compartment. The VSS calibrator changes the AC sine-wave signal from the VSS to a DC square-wave signal. If the axle ratio or tire size is changed, it will be necessary to replace the VSS calibrator. Refer to "Speedometer Calibration."

COMPONENT LOCATION VIEWS

For component location views, refer to figure 5.



- 1. VALVE, BRAKE PRESSURE MODULATOR
- 4. SWITCH, STOP LAMP
- 6. SENSOR, WHEEL SPEED
- 9. BUFFER, VEHICLE SPEED SENSOR
- 10. SENSOR, VEHICLE SPEED

V3436

Figure 5—Component Location Views

DIAGNOSIS

DIAGNOSTIC PROCESS

Before beginning diagnosis on the 4WAL system, you need a detailed description of when the condition occurred from the owner. This information can be useful in duplicating the condition. Always begin diagnosis with a visual inspection of all connectors, wiring, wire routing and retention, and system components. Many times a disconnected or loose connector, blown fuse, corroded terminal, or miss-routed wire is the cause of a malfunction.

If a visual inspection does not reveal the cause of a malfunction, perform the "Functional Test" in this section. **Always start with the Functional Test.** This is a critical step in the quick and accurate diagnosis of any malfunction. It will direct you to the specific system area that is malfunctioning and verify that the diagnostic system is functioning properly. Correct system diagnosis cannot be ensured without starting diagnosis with the Functional Test.

SELF-DIAGNOSTICS

The BPMV performs self-diagnostics and can detect and often isolate system failures. When a malfunction is detected, the BPMV sets a diagnostic trouble code (DTC) that represents the malfunction, turns on the "ANTILOCK" lamp (in most instances), and disables the 4WAL functions while the "ANTILOCK" lamp is on.

The BPMV performs an automatic self-test the first time the vehicle reaches the speed of approximately 12.9 km/h (8 mph) after an ignition cycle. The BPMV cycles the pump motor and each valve to check component operation. If it detects an error, it sets a DTC as described above.

DISPLAYING DIAGNOSTIC TROUBLE CODES

Diagnostic trouble codes (DTCs) can be read with the Tech 1 scan tool or by jumping terminal "H" to terminal "A" of the data link connector (DLC) (figure 6) and counting the "ANTILOCK" lamp flashes. The terminals must be jumped for a few seconds before the DTC will begin to flash. The "ANTILOCK" lamp displays DTCs similar to the malfunction indicator lamp for the fuel and emissions system.

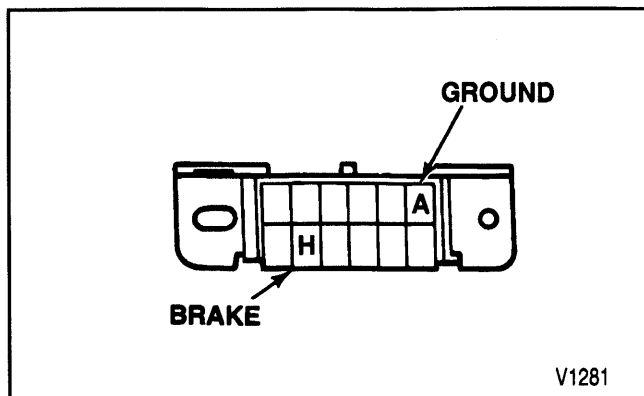


Figure 6—Data Link Connector

CLEARING DIAGNOSTIC TROUBLE CODES

If the "ANTILOCK" indicator lamp is staying on, the DTCs can be cleared with the Tech 1 scan tool or by doing the following procedure. (An engine remote starter can be used in place of the jumper wire for this procedure).

1. Turn the ignition switch to the "ON" position.
2. Use a jumper wire to ground DLC terminal "H" to "A" for 2 seconds.
3. Remove the jumper wire for 1 second.
4. Repeat the grounding for 2 seconds.
5. An indication of success is when the "ANTILOCK" and "BRAKE" lamps light and then turn off.

INTERMITTENTS AND POOR CONNECTIONS

Most intermittent faults are caused by a faulty electrical connection or wiring, although a sticking relay or solenoid can occasionally be at fault. Refer to "Intermittents and Poor Connections" in the Driveability, Emissions, and Electrical Diagnosis Manual for a detailed explanation of how to locate and repair intermittent conditions.

TECH 1 DIAGNOSTICS



Important

- Refer to the Brake System Cartridge Operator's Manual or Mass Storage Cartridge Owner's Manual for additional information about the Tech 1 and the various mode uses.

The Tech 1 has five modes to assist in diagnosing 4WAL system malfunctions. After selecting 4WAL from the select system menu, the Tech 1 will automatically display the Select Mode menu. From here you can select one of five test modes by pressing the appropriate key:

- **MODE F0: DATA LIST**

This mode allows continuous monitoring 4WAL parameters. The Tech 1 displays data parameters in pairs. The display window tells you which parameters are being displayed and the value for them.

The Tech 1 can be programmed to display specific pairs of parameters by following the screen commands. This allows you to monitor specific values that are not normally displayed together.

- **MODE F1: FUNCTION TEST**

This mode allows actuation of the 4WAL system. The Tech 1 will send a signal to the BPMV that causes it to cycle the system. For a short period, the BPMV will cycle the valve and activate the pump motor.

- **MODE F2: TROUBLE CODE**

This mode allows access and clearing of DTCs. The screen will display the DTC and a brief description of what it represents.

- **MODE F3: SNAPSHOT**

This mode provides a tool to help isolate an intermittent condition. You can specify a trigger condition or manually trap the data. No matter which trigger you choose, the Tech 1 captures and stores data before and after the trigger.

- **MODE F4: MISC. TESTS**

This allows researching of the PROM ID to see which version of software is used in the BPMV, history data, history codes, and tire size calibration.

MODE F3 - SNAPSHOT

The "Snapshot" mode provides is a tool to help isolate an intermittent condition. In this mode, you can specify a trigger condition and BPMV diagnostic data is automatically stored before and after the trigger occurrence. You can then display any or all of the stored data.

The operation of the Snapshot mode is divided into three phases; set-up, data capture, and data display.

Setup Phase

1. Press F3 to enter the "Snapshot" mode.
2. Select trigger options are displayed in a self-scrolling menu. Press the function key next to the desired trigger condition.
 - F0: Any Code
 - F1: Single Code
 - F2: Manual Trigger
 - F3: Soft Fault
 - F4: ABS Stop
 - F5: Replay Data
3. When triggering on a single DTC, the Tech 1 will ask you to enter the desired DTC. Enter the two digit DTC followed by the ENTER key.

Data Capture Phase

1. After you specify the trigger condition, the Tech 1 starts collecting data. During this time, you can examine all of the data the same way you do in the Data List mode. The Tech 1 will display a "W" in the lower right-hand corner while it waits for the trigger condition to occur.
2. While the Tech 1 waits for the trigger, the stored data is organized as a number of "samples." The number and state of each parameter and all DTCs are saved for each sample. If more than half of the maximum number of samples occur before the trigger, the oldest data is discarded.
3. The snapshot data is triggered when the specified trigger condition occurs.
 - F0: Any Code - The trigger occurs when the Tech 1 determines a DTC is set. If a DTC is present at the start of the test, the trigger occurs immediately.
 - F1: Single Code - The trigger occurs when the Tech 1 determines the specified DTC is set.
 - F2: Manual Trigger - The Tech 1 waits until you press the ENTER, EXIT, or F9 key to take the snapshot.
 - F3: Soft Fault - The trigger occurs when the BPMV recognizes an intermittent fault. A soft fault is an occurrence like a poor electrical connection that breaks and makes contact again while driving over a rough road.

- F4: ABS Stop - The trigger occurs when the brake, while driving, is applied hard enough to cause the 4WAL system to activate.



Important

- While the Tech 1 is waiting for any trigger, the ENTER, EXIT, or F9 key can always be used to force a trigger.
4. After the trigger occurs, the Tech 1 continues to save data samples until it's memory is full. The Tech 1 display shows the trigger occurred by replacing the "W" in the lower right hand corner with a "T." The "T" will change to a "0" when the memory is full. The data capture terminates automatically and the Tech 1 goes on to the Data Display phase.
 5. Pressing EXIT terminates the Data Capture phase and will display captured data.

Data Display Phase

1. The Data Display phase is indicated with a number (initially zero) in the lower right hand corner of the display. The number indicates which sample is being displayed. Use the arrow keys to sequence through the data.
 - Sample "-1" is the sample immediately preceding the trigger. Sample "+1" is the sample immediately after the trigger; and so on.
 - Press F4 to go to the earliest sample in memory or F6 to go to the latest sample.
 - Press F5 to return to the "0" sample.
2. Use the YES and NO keys to display the data parameters of the selected samples. If you want to see the DTCs for that sample, press the F2 key and the DTCs will be displayed.

MODE F4 - MISCELLANEOUS TESTS

This mode provides PROM ID, history data, history codes, and tire size calibration.

Prom ID

This function simply displays the version of 4WAL software in the BPMV being tested.

1. Select PROM ID by pressing F0.
2. The Tech 1 will prompt you to turn the ignition switch "OFF" then "ON."
3. The display will show the 4WAL unit software version.

History Data

This function identifies drive cycle (ignition counts) and 4WAL activation counts relative to when DTCs were stored. There are multiple blocks of history records.

1. Select HISTORY DATA by pressing F1.
2. The Tech 1 will prompt you to turn the ignition switch "OFF" then "ON."
3. The most recent history block will be displayed.
 - Use the arrow keys to scroll through the different data blocks. The most negative number being the oldest stored block.

5E1-8 FOUR WHEEL ANTILOCK BRAKE SYSTEM

History Code

This function identifies which DTCs are stored within each history block. This information is available in two ways. Stored Codes lists the block number and all DTCs stored in that block by number only. Enhanced Codes provides the DTC numbers and a description of the DTCs stored in the block.

1. Select HISTORY CODE by pressing F2.
2. Select F0 for stored codes or F1 for enhanced codes.
3. The Tech 1 will prompt you to turn the ignition switch "OFF" then "ON."
4. The display will show the block number and code information.

Tire Size Cal

This function has two options; read tire size cal and new tire size cal. Read tire size cal allows you to read

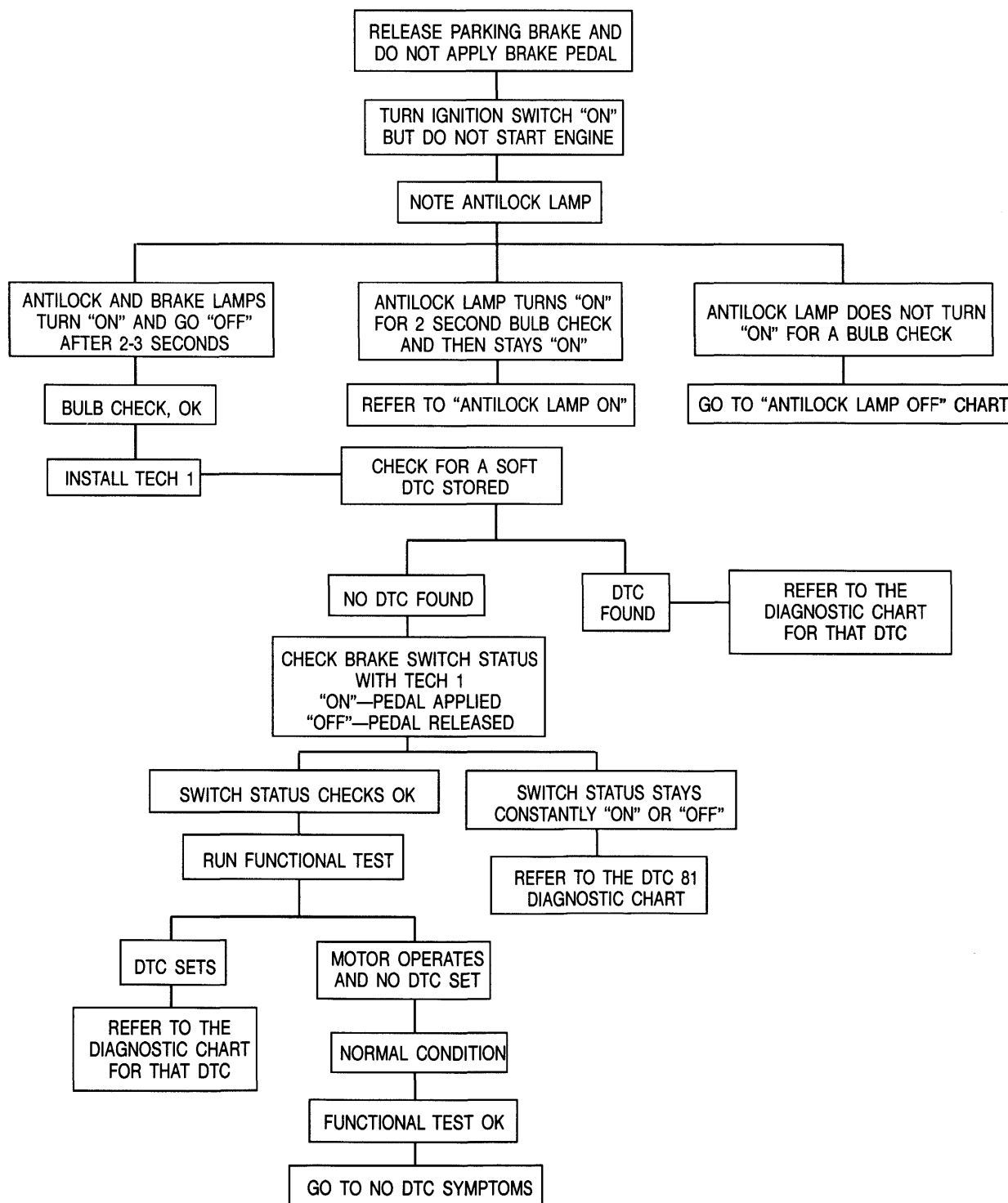
the tire size calibration stored in the BPMV module. New tire size cal allows you to program a new tire size calibration into the BPMV module. Only predetermined tire sizes can be selected

1. Select TIRE SIZE CAL by pressing F3.
2. Use the arrow keys to scroll the available tire size options.
3. The arrow symbol indicates the current selected size.
4. After you select the correct size, press the ENTER key to program the new tire size calibration.

DIAGNOSTIC CHARTS

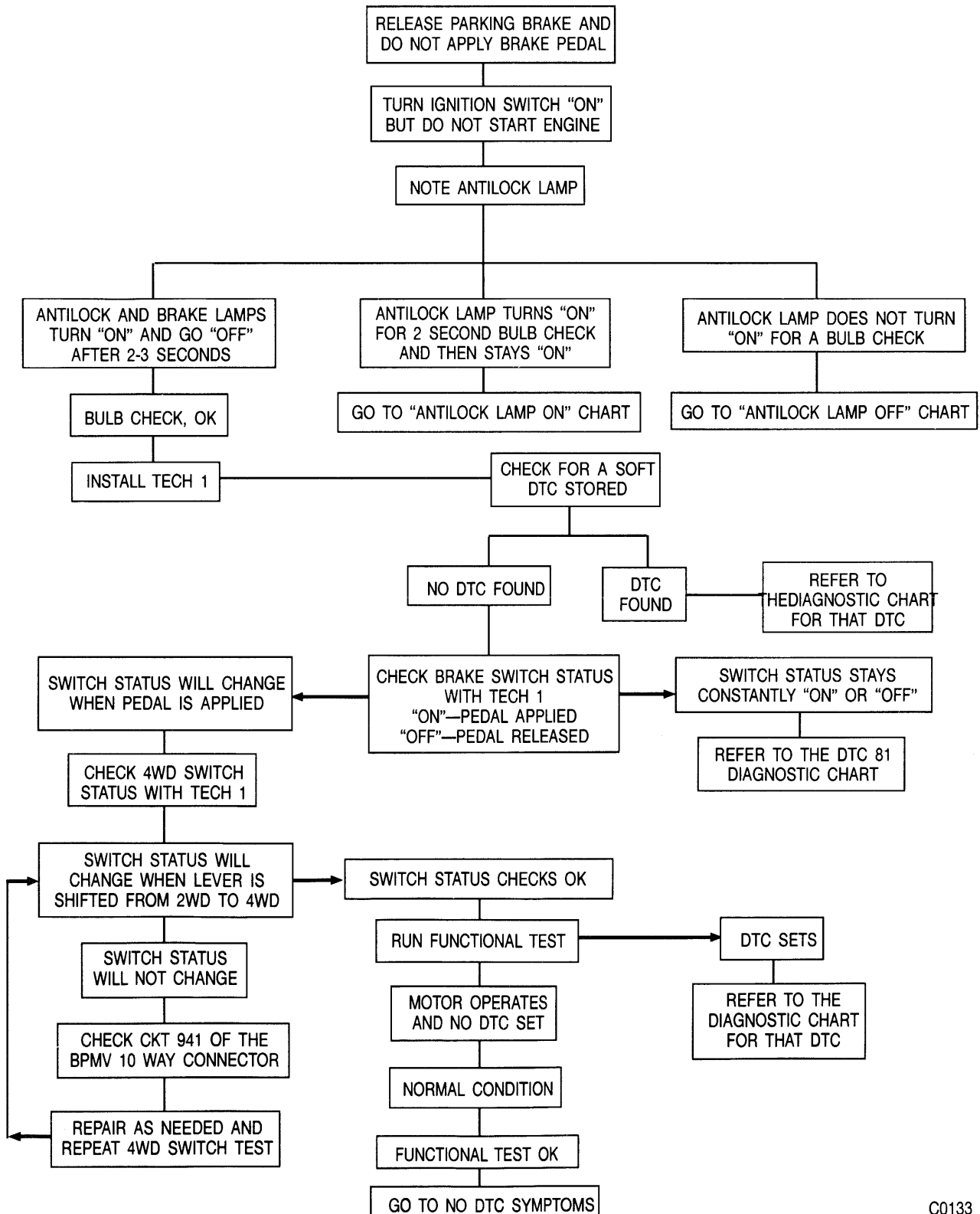
Refer to the Functional Test as a starting point for all diagnosis. Failure to perform the Functional Test may result in extended diagnostic time, incorrect diagnosis, and incorrect parts replacement. Refer to figures 7 and 8 for the wiring diagram and connector face views. Charts for symptom diagnosis follow.

FUNCTIONAL TEST (2WD AND AWD)



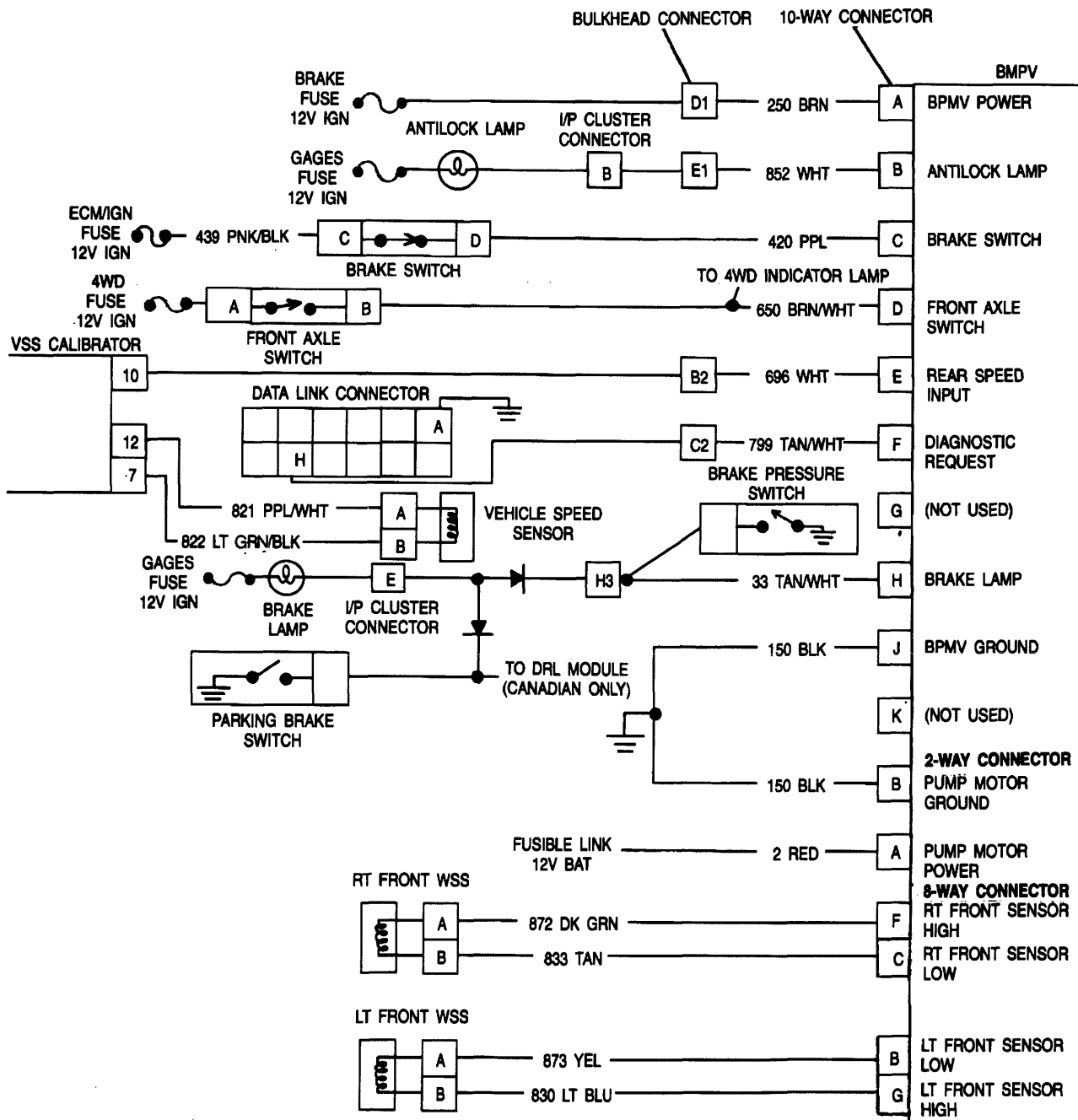
5E1-10 FOUR WHEEL ANTILOCK BRAKE SYSTEM

FUNCTIONAL TEST (4WD)



DIAGNOSTIC TROUBLE CODE AND SYMPTOM TABLE		
Diagnostic Trouble Code	Description/Symptom	Page #
—	Antilock Lamp "ON"	5E1-14
—	Antilock Lamp "OFF"	5E1-15
—	Brake Pedal Pulses	5E1-16
—	Wheel Pull During Hard Braking	5E1-17
21	Right Front Wheel Speed Sensor or Circuit Open	5E1-18
22	Missing Right Front Speed Signal	5E1-20
23	Erratic Right Front Wheel Speed Sensor	5E1-22
25	Left Front Wheel Speed Sensor or Circuit Open	5E1-24
26	Missing Left Front Speed Signal	5E1-26
27	Erratic Left Front Wheel Speed Sensor	5E1-28
29	Simultaneous Drop-Out of Front Wheel Speed Sensors	5E1-30
35	Open or Grounded Rear Speed Signal Circuit	5E1-32
36	Missing Rear Speed Signal	5E1-34
37	Erratic Rear Speed Signal	5E1-36
38	Wheel Speed Error	5E1-38
41-54	Control Valves	5E1-40
65-66	Open or Shorted Pump Motor Relay	5E1-42
67	Open Motor Circuit or Shorted BPMV Output	5E1-44
68	Locked Motor or Shorted Motor Circuit	5E1-44
71-74	Memory Errors	5E1-46
81	Brake Switch Circuit Shorted or Open	5E1-48
86	Shorted Antilock Indicator Lamp	5E1-50
88	Shorted Brake Warning Lamp	5E1-50

5E1-12 FOUR WHEEL ANTILOCK BRAKE SYSTEM



3105r3743

Figure 7—4WAL Wiring Diagram

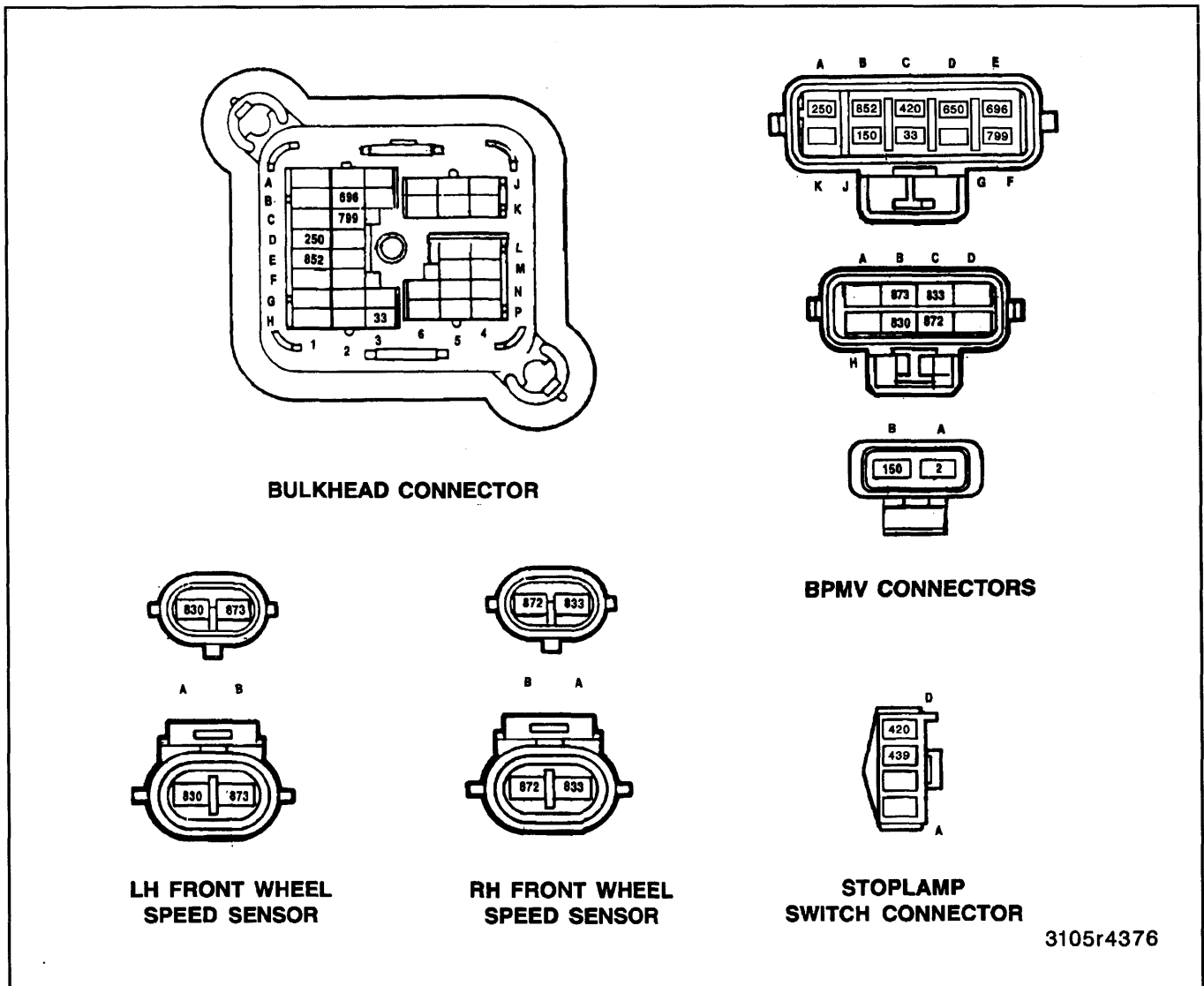
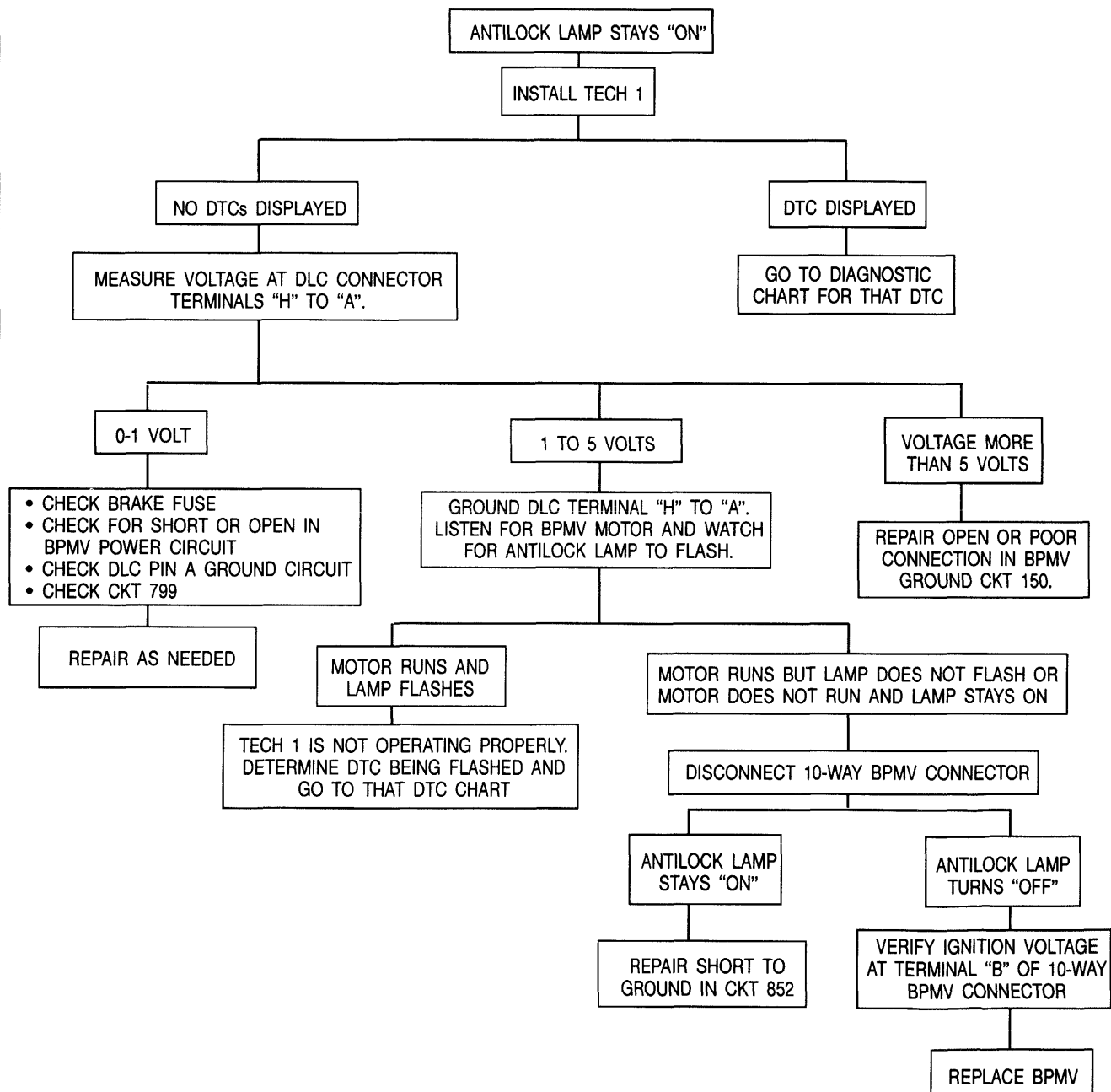


Figure 8—4WAL Connector Face Views

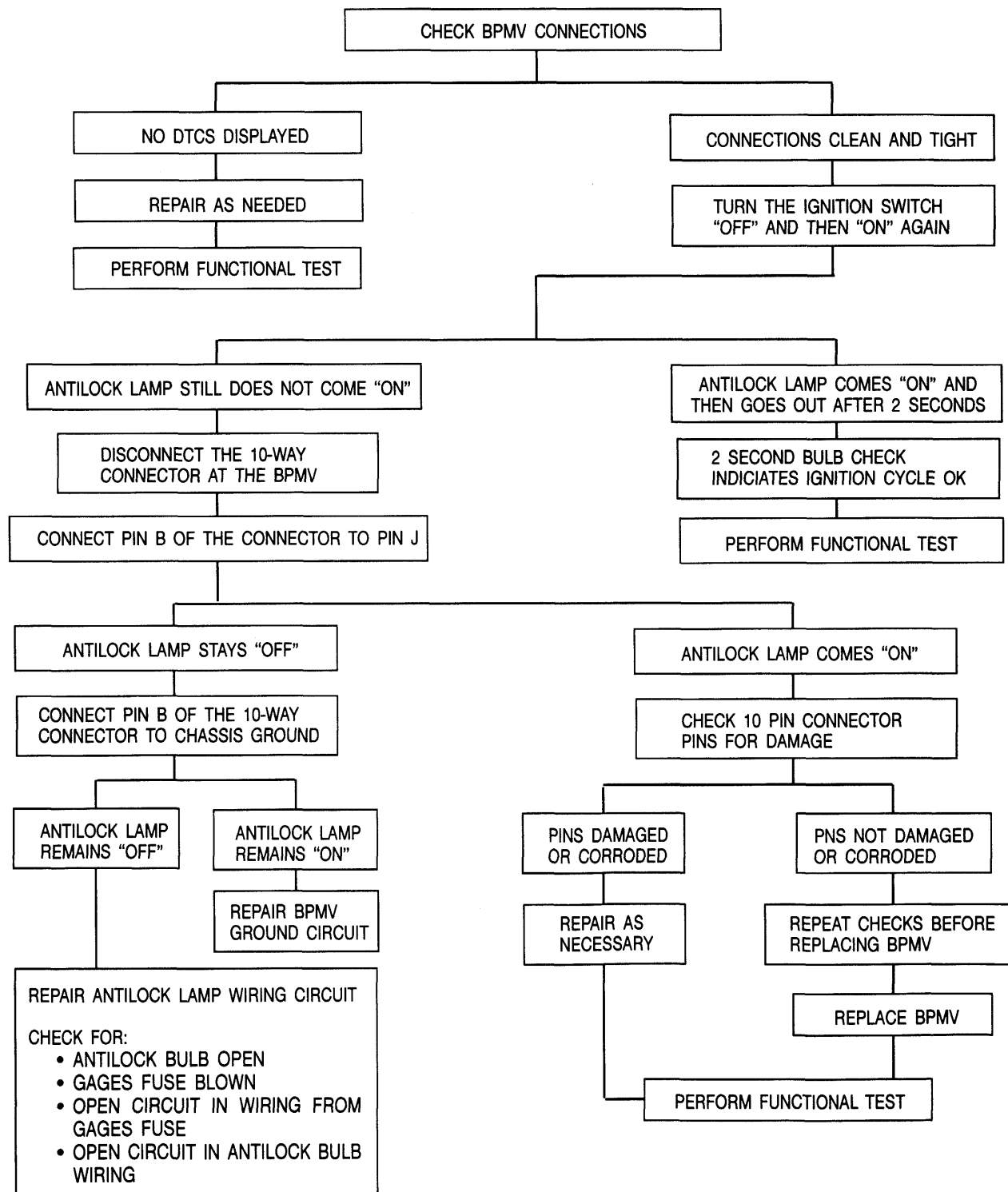
5E1-14 FOUR WHEEL ANTILOCK BRAKE SYSTEM

ANTILOCK LAMP "ON"

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.

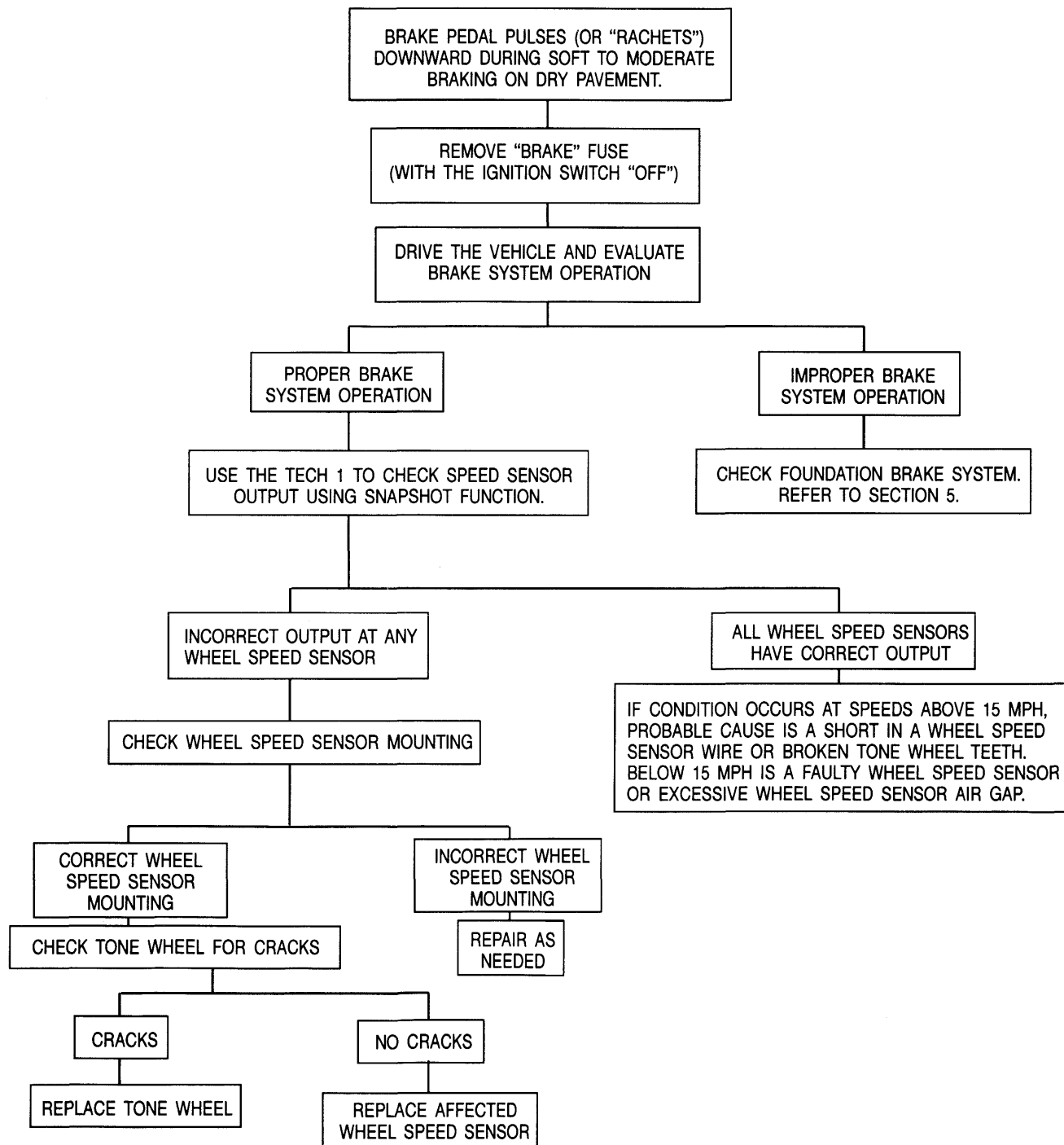


ANTILOCK LAMP "OFF"



5E1-16 FOUR WHEEL ANTILOCK BRAKE SYSTEM

BRAKE PEDAL PULSES (NO DTC CONDITION)



WHEEL PULL DURING HARD BRAKING (NO DTC CONDITION)

WHEEL PULL DURING HARD BRAKING (WHEEL LOCK CAUSES ANTILOCK CONTROL ACTION). DOES NOT OCCUR DURING SOFT TO MODERATE BRAKING ON DRY PAVEMENT.

IGNITION SWITCH "OFF"

REMOVE "BRAKE" FUSE AND ROAD TEST

CONDITION STOPS

CHECK FOR LOW WHEEL SPEED
SENSOR DROP OUT WITH TECH 1

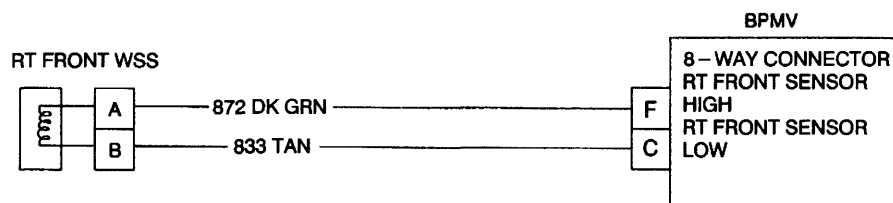
REFER TO DIAGNOSTIC CHART FOR
AFFECTED WHEEL SPEED SENSOR

CONDITION STILL OCCURS

REPAIR FOUNDATION BRAKES.
REFER TO SECTION 5.

C0089

5E1-18 FOUR WHEEL ANTILOCK BRAKE SYSTEM



2905r4359

DIAGNOSTIC TROUBLE CODE 21 RIGHT FRONT WHEEL SPEED SENSOR OR CIRCUIT OPEN

CIRCUIT DESCRIPTION:

A DTC 21 relates to an open condition in the right front WSS or circuit. This DTC is a soft fault and sets when the vehicle is at zero mph. The BPMV checks for the proper resistance in the right front WSS circuit. Any condition that creates excessive resistance or an open condition in the right front WSS circuit can cause this DTC to set.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check BPMV 8-way connector pins C and F for looseness, corrosion, etc.
- Measure the resistance of BPMV 8-way connector pins C and F.

- Measure resistance at the right front WSS connector.
- Check right front WSS output using the Tech 1.
- Check for intermittent opens in CKTs 833 and 872.

DIAGNOSTIC AIDS:

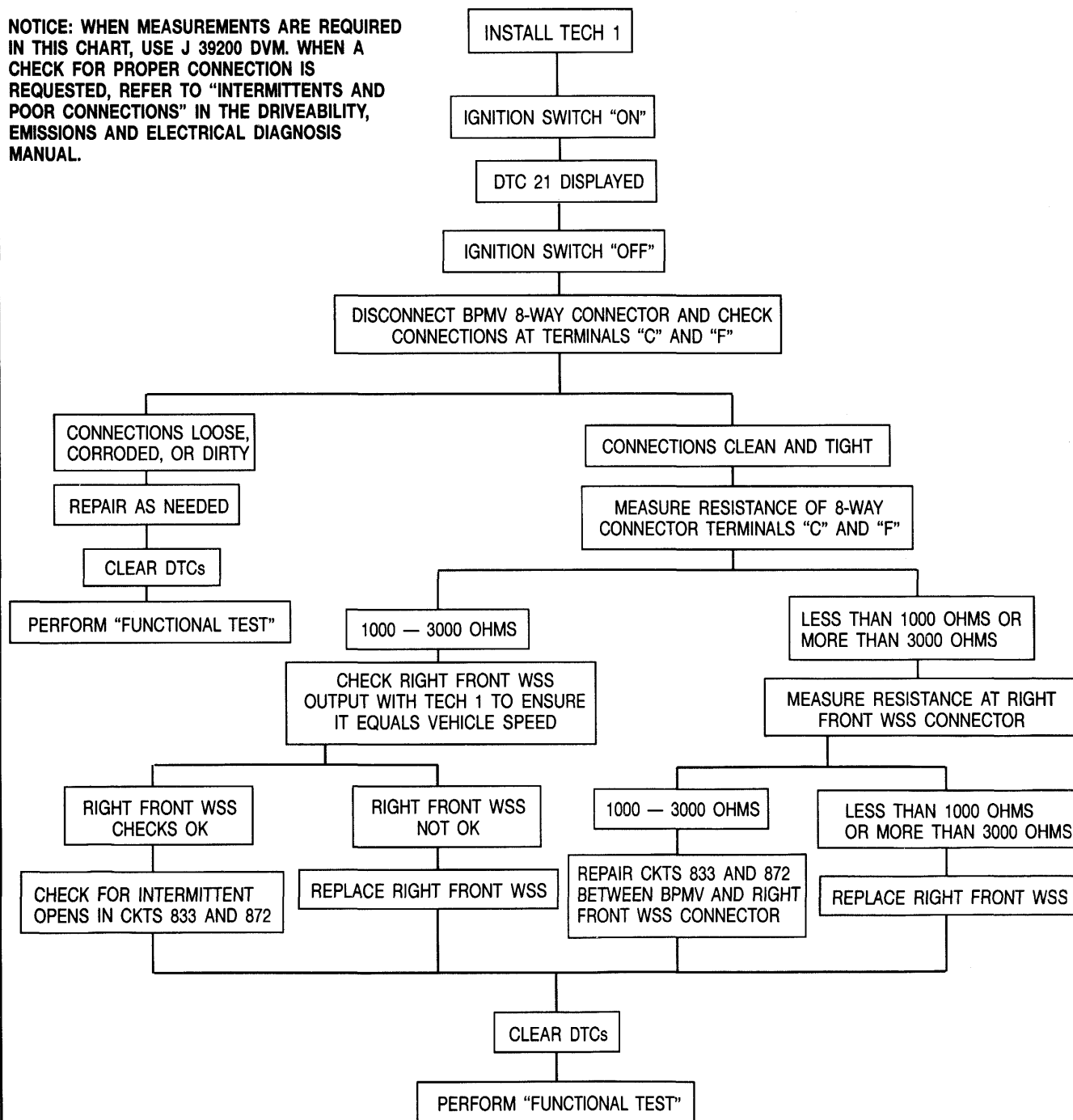
This DTC can only be set by a malfunction in the right front WSS and circuit.

This DTC can be caused by someone disconnecting one or more speed sensors to get the wiring out of the way while doing brake or suspension repairs and then forgetting to plug the connectors back together.

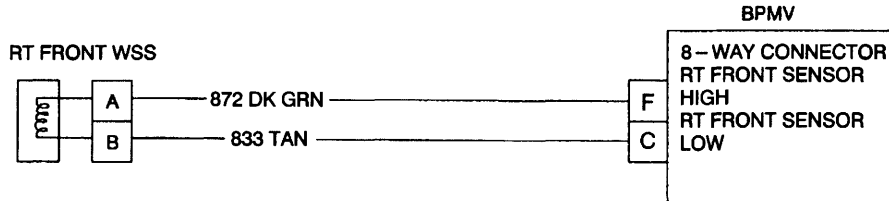
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

**DTC 21
RIGHT FRONT WHEEL SPEED SENSOR OR CIRCUIT OPEN**

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-20 FOUR WHEEL ANTILOCK BRAKE SYSTEM



2905r4359

DIAGNOSTIC TROUBLE CODE 22 MISSING RIGHT FRONT SPEED SIGNAL

CIRCUIT DESCRIPTION:

A DTC 22 relates to the BPMV losing the right front WSS signal for at least 5 seconds at speeds over 13 km/h (8 mph) with the brake pedal released. If a DTC 21 is also stored, use that diagnostic chart. This DTC can be caused by a faulty WSS, tone wheel, or a circuit condition.

! Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check for speed output from the right front WSS using the Tech 1.
- Check BPMV 8-way connector pins C and F for looseness, corrosion, etc.

- Measure the resistance of BPMV 8-way connector pins C and F.
- Check connection at the right front WSS connector.
- Measure resistance at the right front WSS connector.
- Check wiring harness for chafing.
- Check if intermittent condition requires replacing the right front WSS or harness.

DIAGNOSTIC AIDS:

If a DTC 21 is also stored, refer to that diagnostic chart. If this DTC occurs on ice, check for brake drag or frozen brake components.

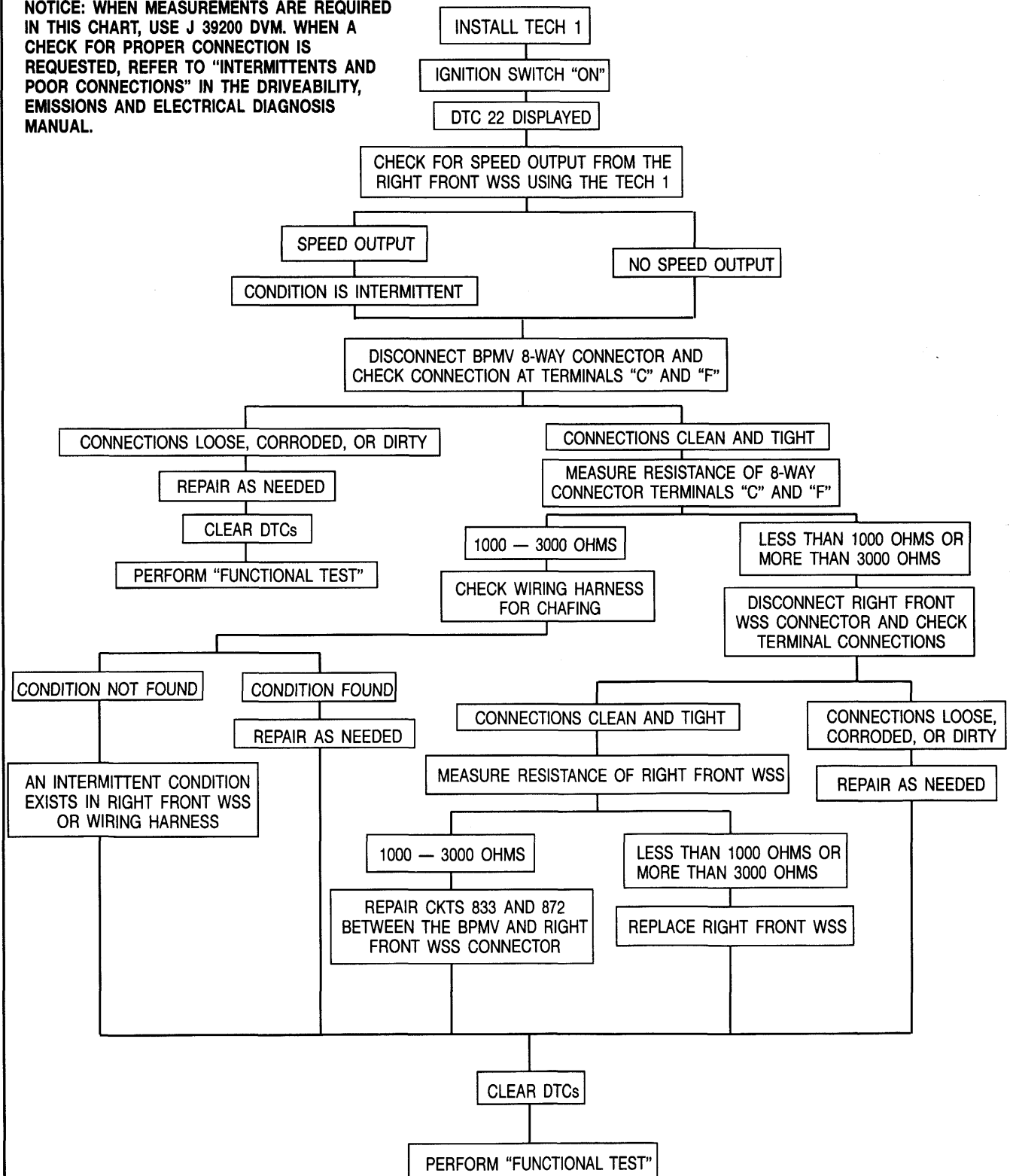
This DTC can only be set by a malfunction in the right front WSS and circuit.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

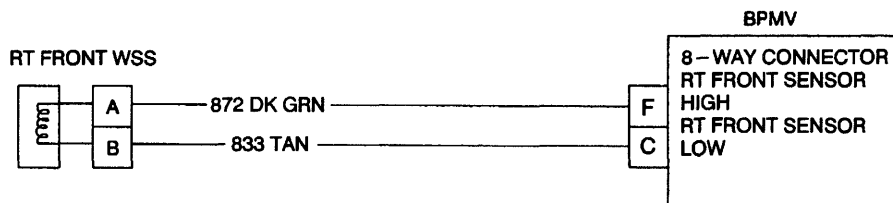
DTC 22

MISSING RIGHT FRONT SPEED SIGNAL

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-22 FOUR WHEEL ANTILOCK BRAKE SYSTEM



2905r4359

DIAGNOSTIC TROUBLE CODE 23 ERRATIC RIGHT FRONT WHEEL SPEED SENSOR

CIRCUIT DESCRIPTION:

A DTC 23 relates to the BPMV receiving an erratic signal from the right front WSS. This DTC sets after the speed signal leaves and returns three times within one ignition cycle at speeds over 19 km/h (12 mph) (brake released) or 32 km/h (20 mph) (brake applied). A faulty right front WSS, tone wheel, electrical connector, or circuit can cause this DTC to set.

! Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check BPMV 8-way connector pins C and F for looseness, corrosion, etc.
- Measure the resistance of BPMV 8-way connector pins C and F.

- Measure resistance at the right front WSS connector.
- Check CKTs 833 and 872 for opens, shorts, or poor connections.
- Inspect the right front WSS and tone wheel for physical damage or excessive clearance.

DIAGNOSTIC AIDS:

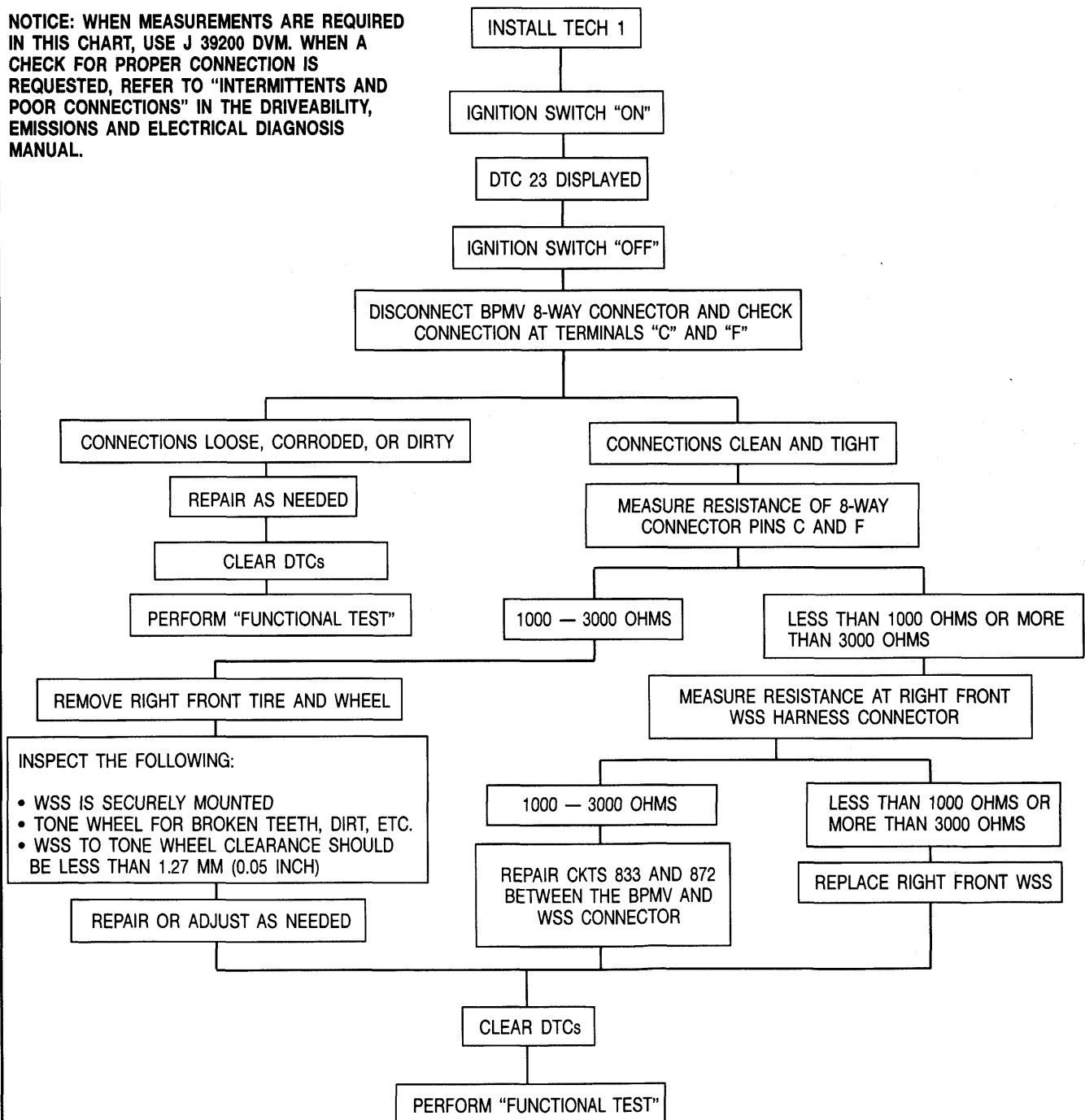
Do not rotate the wheel while measuring WSS resistance.

This DTC can only be set by a malfunction in the right front WSS and circuit.

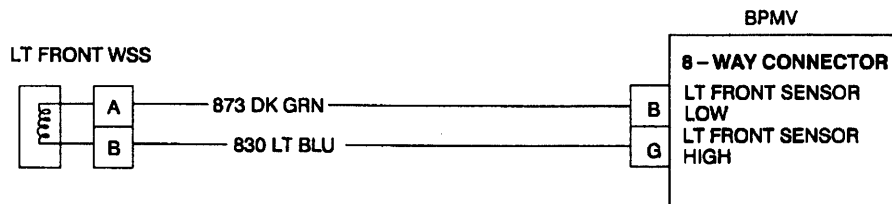
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 23 ERRATIC RIGHT FRONT WHEEL SPEED SENSOR

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-24 FOUR WHEEL ANTILOCK BRAKE SYSTEM



2905r4360

DIAGNOSTIC TROUBLE CODE 25 LEFT FRONT WHEEL SPEED SENSOR OR CIRCUIT OPEN

CIRCUIT DESCRIPTION:

A DTC 25 relates to an open condition in the left front WSS or circuit. This DTC is a soft fault and sets when the vehicle is at zero mph. The BPMV checks for the proper resistance in the left front WSS. Any condition that creates excessive resistance or an open condition in the left front WSS circuit can cause this DTC to set.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check BPMV 8-way connector pins B and G for looseness, corrosion, etc.

- Measure the resistance of BPMV 8-way connector pins B and G.
- Measure resistance at the left front WSS connector.
- Check right front WSS output using the Tech 1.
- Check for intermittent opens in CKTs 830 and 873.

DIAGNOSTIC AIDS:

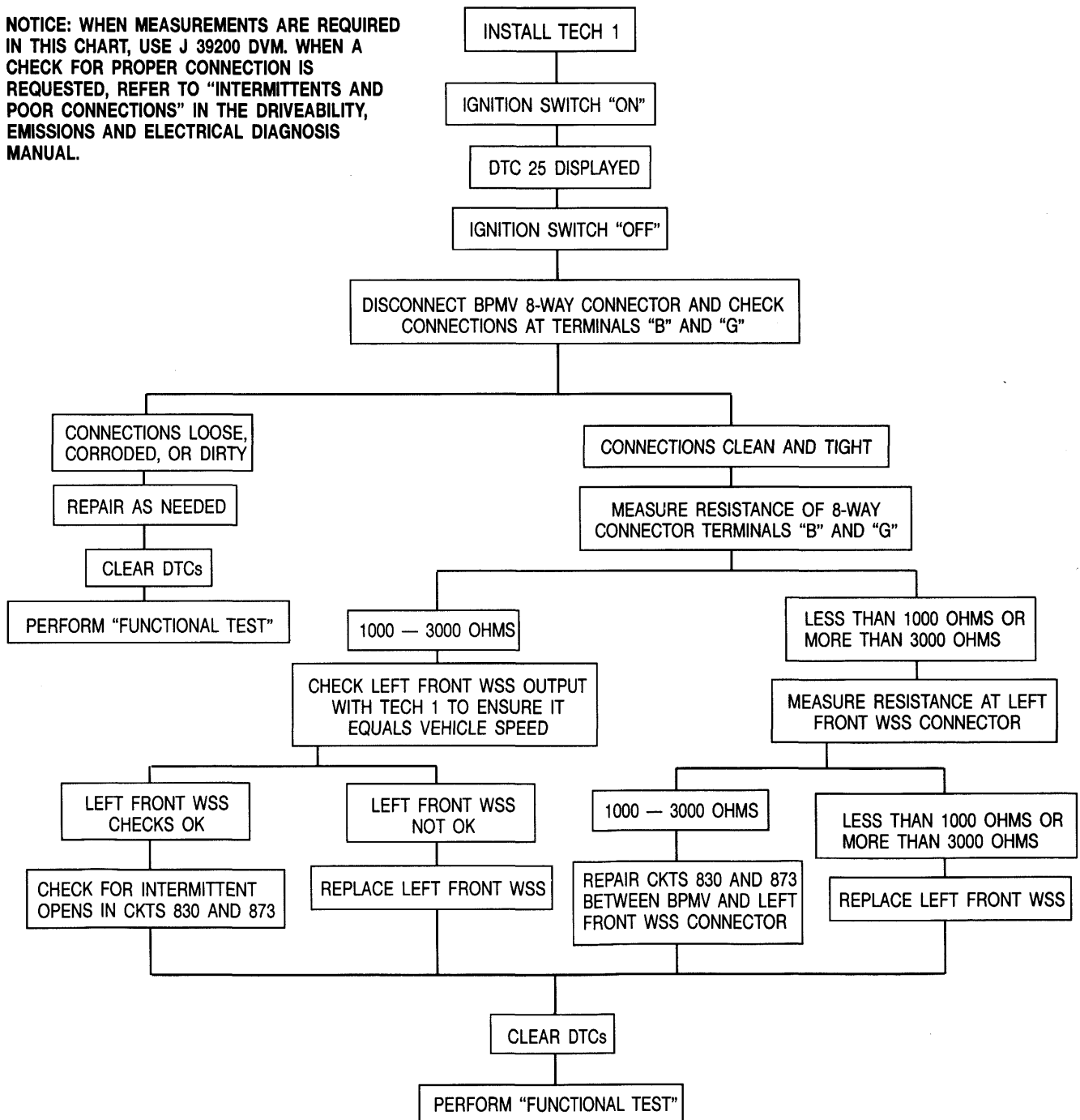
This DTC can only be set by a malfunction in the left front WSS and circuit.

This DTC can be caused by someone disconnecting one or more speed sensors to get the wiring out of the way while doing brake or suspension repairs and then forgetting to plug the connectors back together.

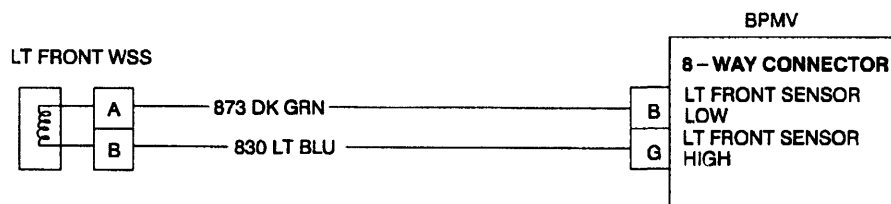
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 25 LEFT FRONT WHEEL SPEED SENSOR OR CIRCUIT OPEN

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-26 FOUR WHEEL ANTILOCK BRAKE SYSTEM



2905r4360

DIAGNOSTIC TROUBLE CODE 26 MISSING LEFT FRONT SPEED SIGNAL

CIRCUIT DESCRIPTION:

A DTC 26 relates to the BPMV losing the left front WSS signal for at least 5 seconds at speeds over 13 km/h (8 mph) with the brake pedal released. If a DTC 25 is also stored, use that diagnostic chart. This DTC can be caused by a faulty WSS, tone wheel, or a circuit condition.

Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check for speed output from the left front WSS using the Tech 1.
- Check BPMV 8-way connector pins B and G for looseness, corrosion, etc.

- Measure the resistance of BPMV 8-way connector pins B and G.
- Check connections at the left front WSS connector.
- Measure resistance at the left front WSS connector.
- Check wiring harness for chafing.
- Check if intermittent condition requires replacing the left front WSS or harness.

DIAGNOSTIC AIDS:

If a DTC 25 is also stored, refer to that diagnostic chart. If this DTC occurs on ice, check for brake drag or frozen brake components.

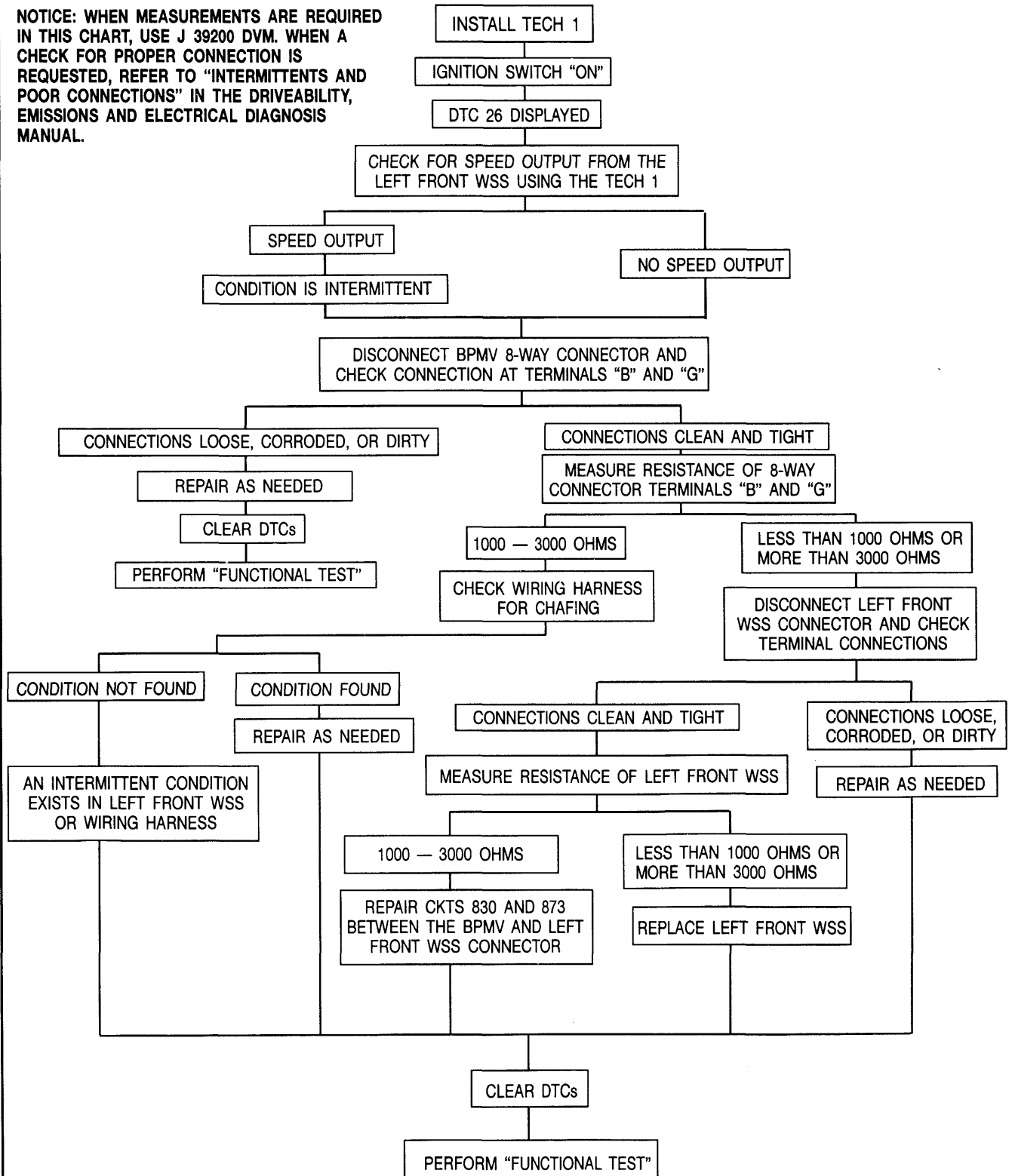
This DTC can only be set by a malfunction in the left front WSS and circuit.

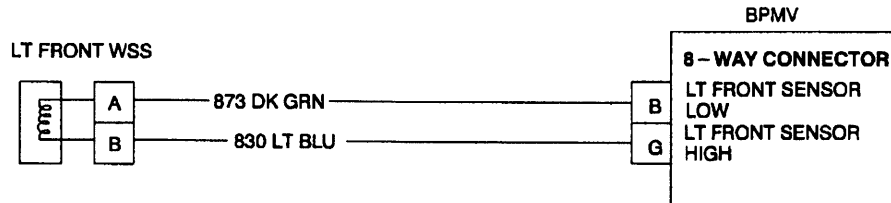
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 26

MISSING LEFT FRONT SPEED SIGNAL

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.





2905r4360

DIAGNOSTIC TROUBLE CODE 27 ERRATIC LEFT FRONT WHEEL SPEED SENSOR

CIRCUIT DESCRIPTION:

A DTC 27 relates to the BPMV receiving an erratic signal from the left front WSS. This DTC sets after the left front speed signal leaves and returns three times within one ignition cycle at speeds over 19 km/h (12 mph) (brake released) or 32 km/h (20 mph) (brake applied). A faulty left front WSS, tone wheel, electrical connector, or circuit can cause this DTC to set.

Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check BPMV 8-way connector pins B and G for looseness, corrosion, etc.

- Measure the resistance of BPMV 8-way connector pins B and G.
- Measure resistance at the left front WSS connector.
- Check CKTs 830 and 873 for opens, shorts, or poor connections.
- Inspect the left front WSS and tone wheel for physical damage or excessive clearance.

DIAGNOSTIC AIDS:

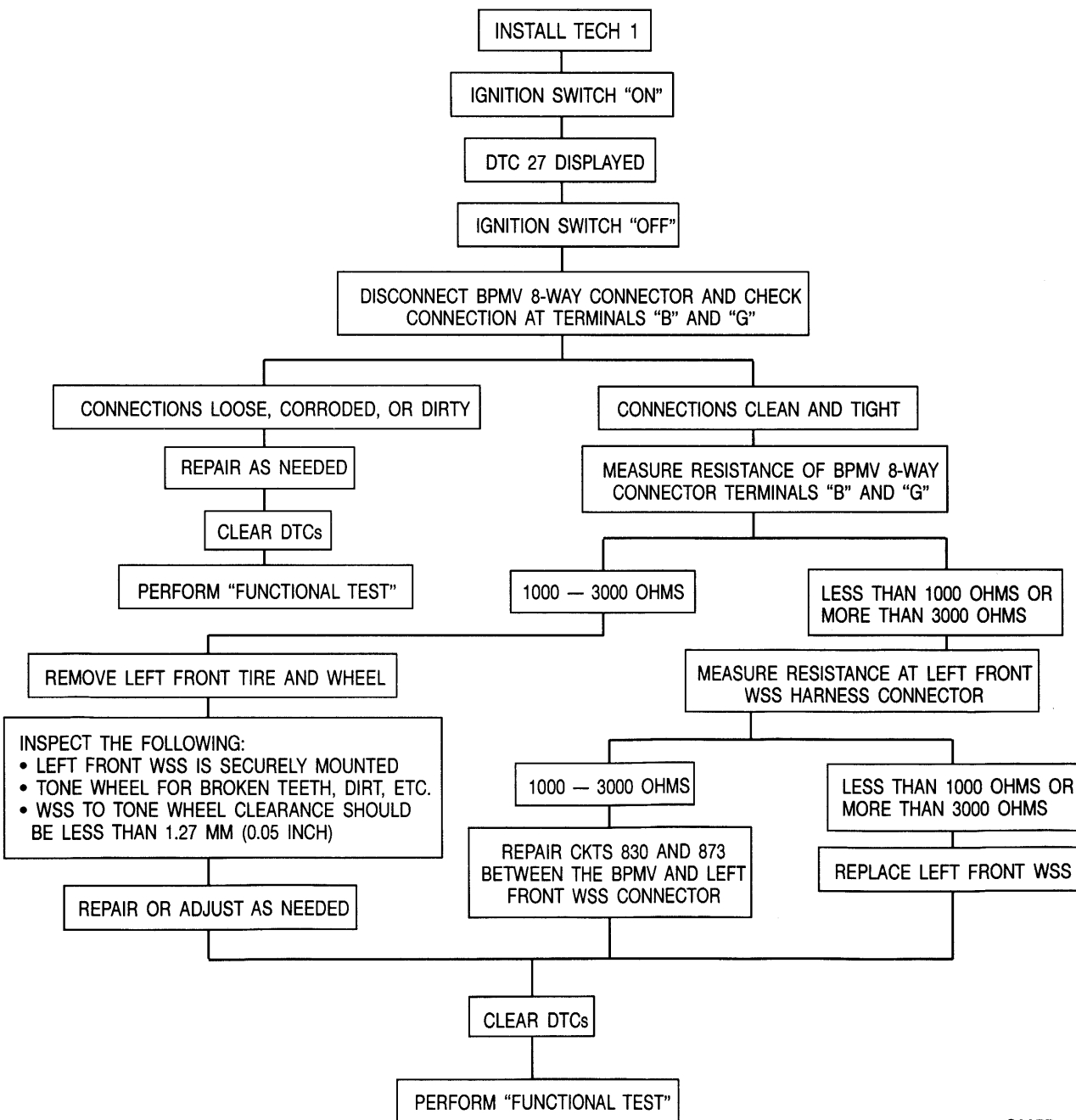
Do not rotate the wheel while measuring WSS resistance.

This DTC can only be set by a malfunction in the left front WSS and circuit.

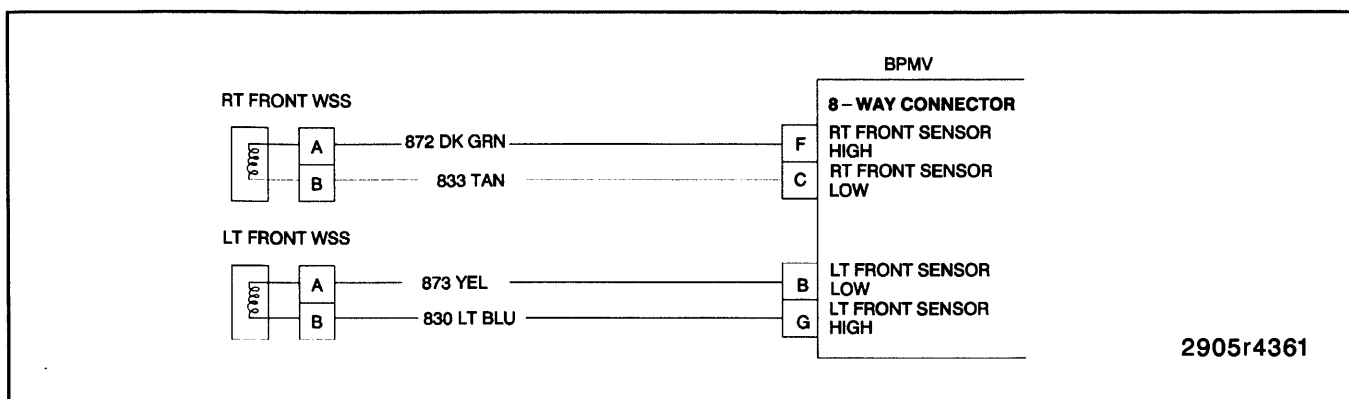
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 27 ERRATIC LEFT FRONT WHEEL SPEED SENSOR

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-30 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 29 SIMULTANEOUS DROP-OUT OF FRONT WHEEL SPEED SENSORS

CIRCUIT DESCRIPTION:

A DTC 29 relates to the BPMV losing the signals from both front WSSs with the vehicle at speeds over 19 km/h (12 mph) (brake released) or 32 km/h (20 mph) (brake applied). The 8-way harness connector or the BPMV are the most probable causes for this DTC.

TEST DESCRIPTION:

- Check the condition of the BPMV 8-way connector and harness.
- Check all front WSS resistance values.

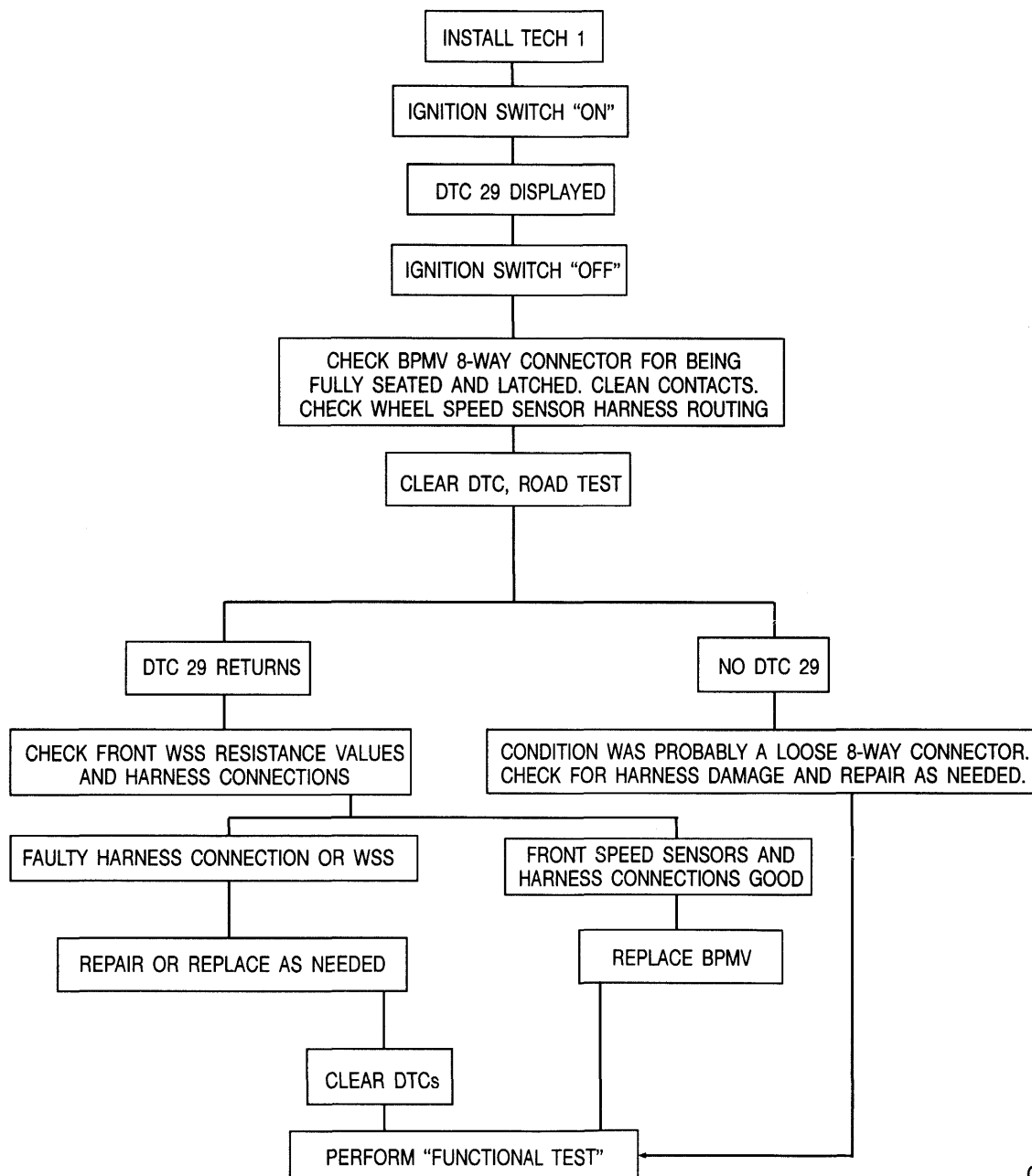
DIAGNOSTIC AIDS:

Do not rotate the wheel while measuring WSS resistance.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

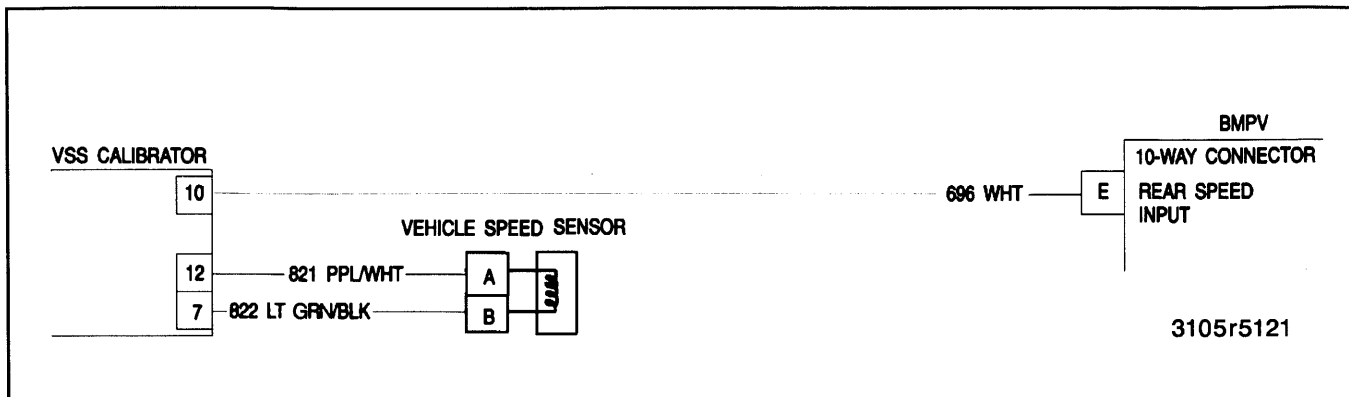
DTC 29

SIMULTANEOUS DROP-OUT OF FRONT WHEEL SPEED SENSORS



C0184

5E1-32 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 35 OPEN OR GROUNDED REAR SPEED SIGNAL CIRCUIT

CIRCUIT DESCRIPTION:

A DTC 35 relates to the BPMV not seeing the speed signal from the VSS calibrator. A faulty VSS calibrator or CKT 696 condition can cause this DTC to set.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check the voltage at BPMV 10-way connector pins E and J.
- Check CKT 696 for open or short conditions.
- Check for a faulty VSS calibrator.

DIAGNOSTIC AIDS:

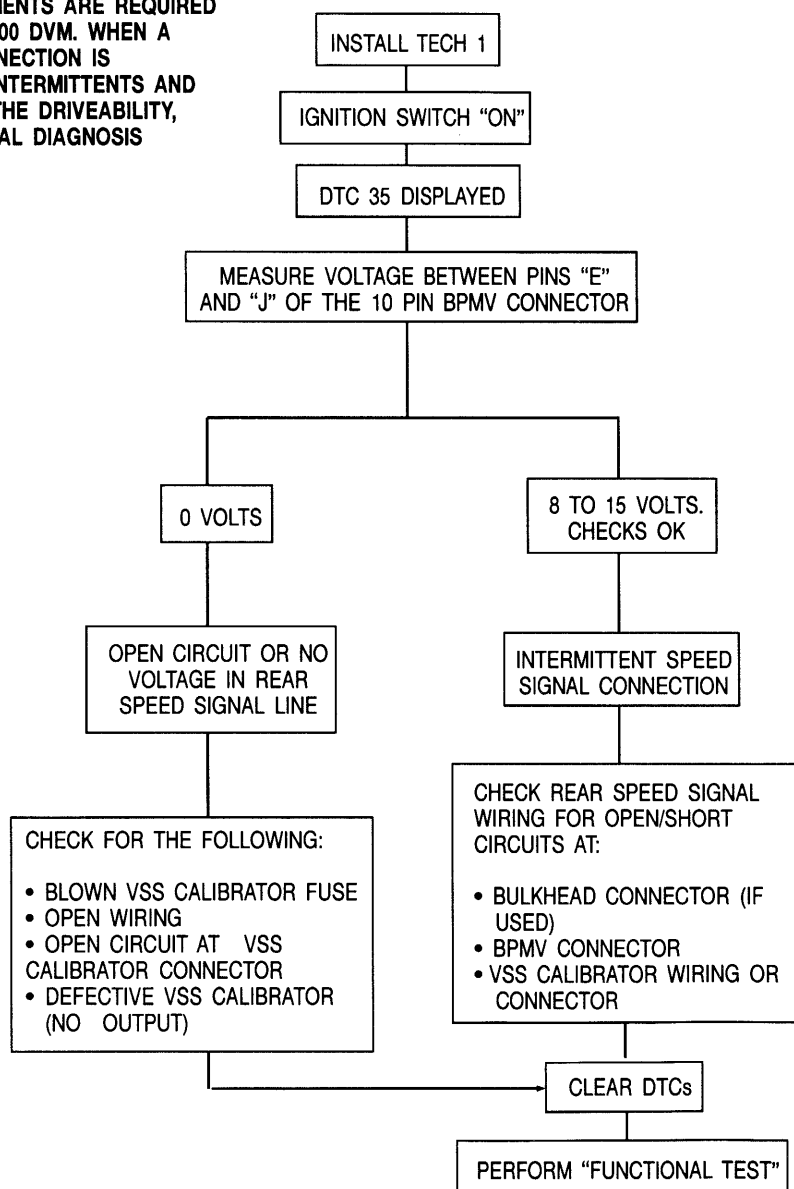
If the voltage readings are low or varying, the battery, charging system, or intermittent connections could be the cause. Check these areas before replacing any components.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

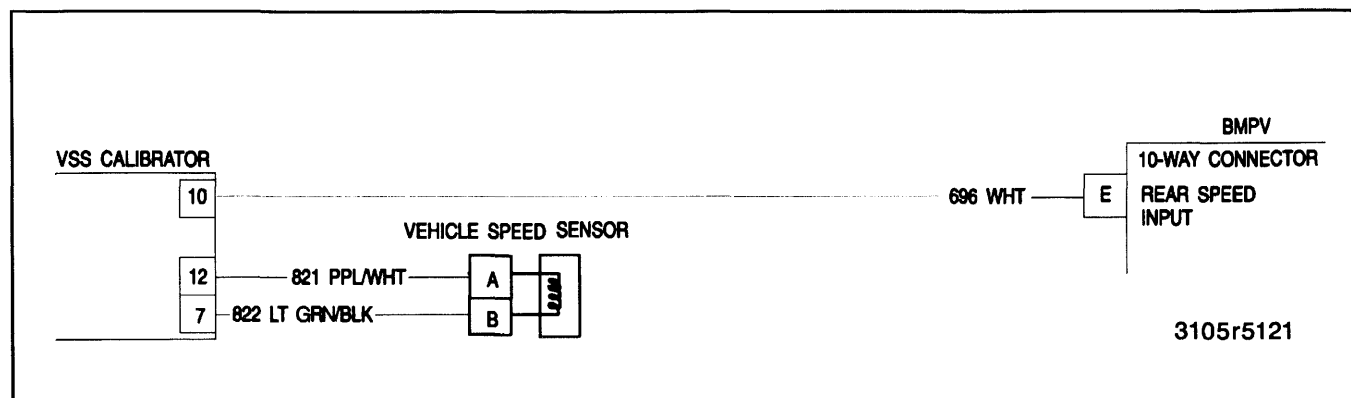
DTC 35

OPEN OR GROUNDED REAR SPEED SIGNAL CIRCUIT

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-34 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 36 MISSING REAR SPEED SIGNAL

CIRCUIT DESCRIPTION:

A DTC 36 relates to the BPMV losing the VSS calibrator signal for at least 5 seconds at speeds over 13 km/h (8 mph) with the brake pedal released. If a DTC 35 is also stored, use that diagnostic chart. This DTC can be set by a faulty VSS, VSS calibrator, or circuit conditions in CKTs 696, 821, and 822.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Measure the resistance of the VSS.
- Measure the resistance of CKTs 821 and 822.

- Check the voltage applied to the BPMV through CKT 696.
- Check the connections in the VSS and VSS calibrator circuits.

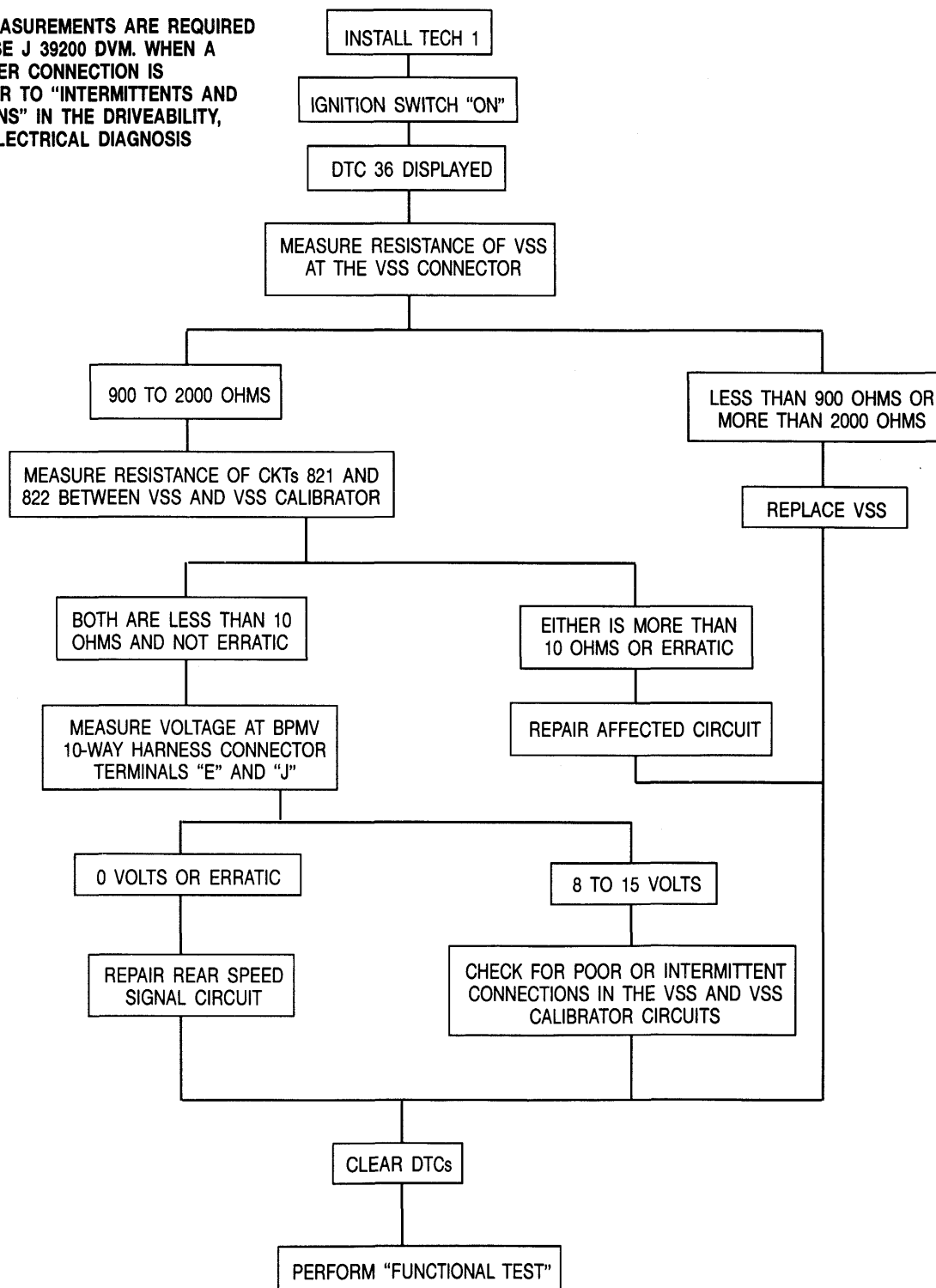
DIAGNOSTIC AIDS:

If the voltage readings are low or varying, the battery, charging system, or intermittent connections could be the cause. Check these areas before replacing any components.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

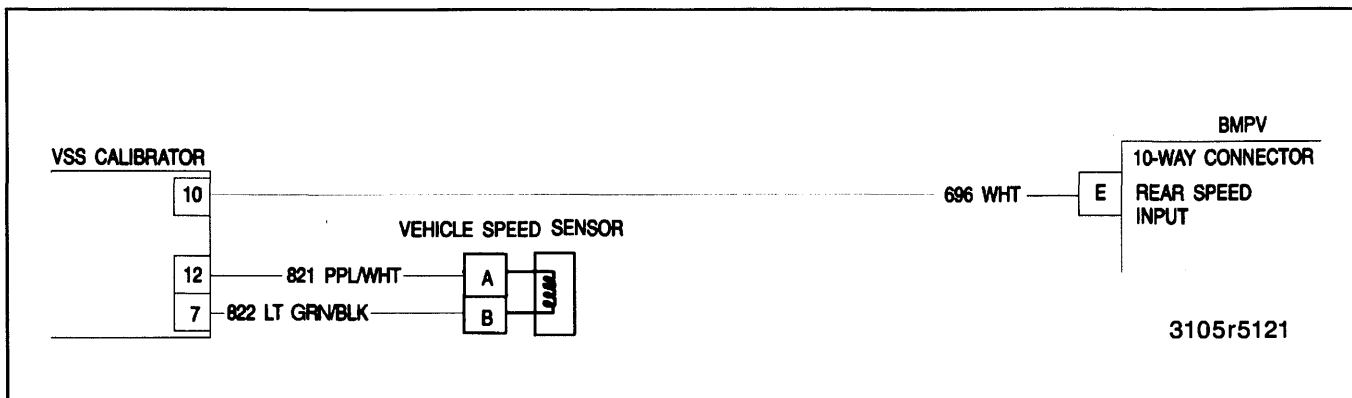
DTC 36 MISSING REAR SPEED SIGNAL

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



C0208

5E1-36 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 37 ERRATIC REAR SPEED SIGNAL

CIRCUIT DESCRIPTION:

A DTC 37 relates to the BPMV seeing the rear speed signal line drop out and return. This DTC can be caused by a malfunction in the VSS, VSS calibrator or CKT 696.

! Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check if all systems are receiving an erratic speed signal or if it is just the 4WAL system.

- Check the VSS output using the Tech 1.
- Check the resistance of the VSS.
- Check for an open condition in CKTs 821 and 822.
- Check for excessive resistance in CKT 696.
- Measure voltage at BPMV 10-way connector pins E and J.

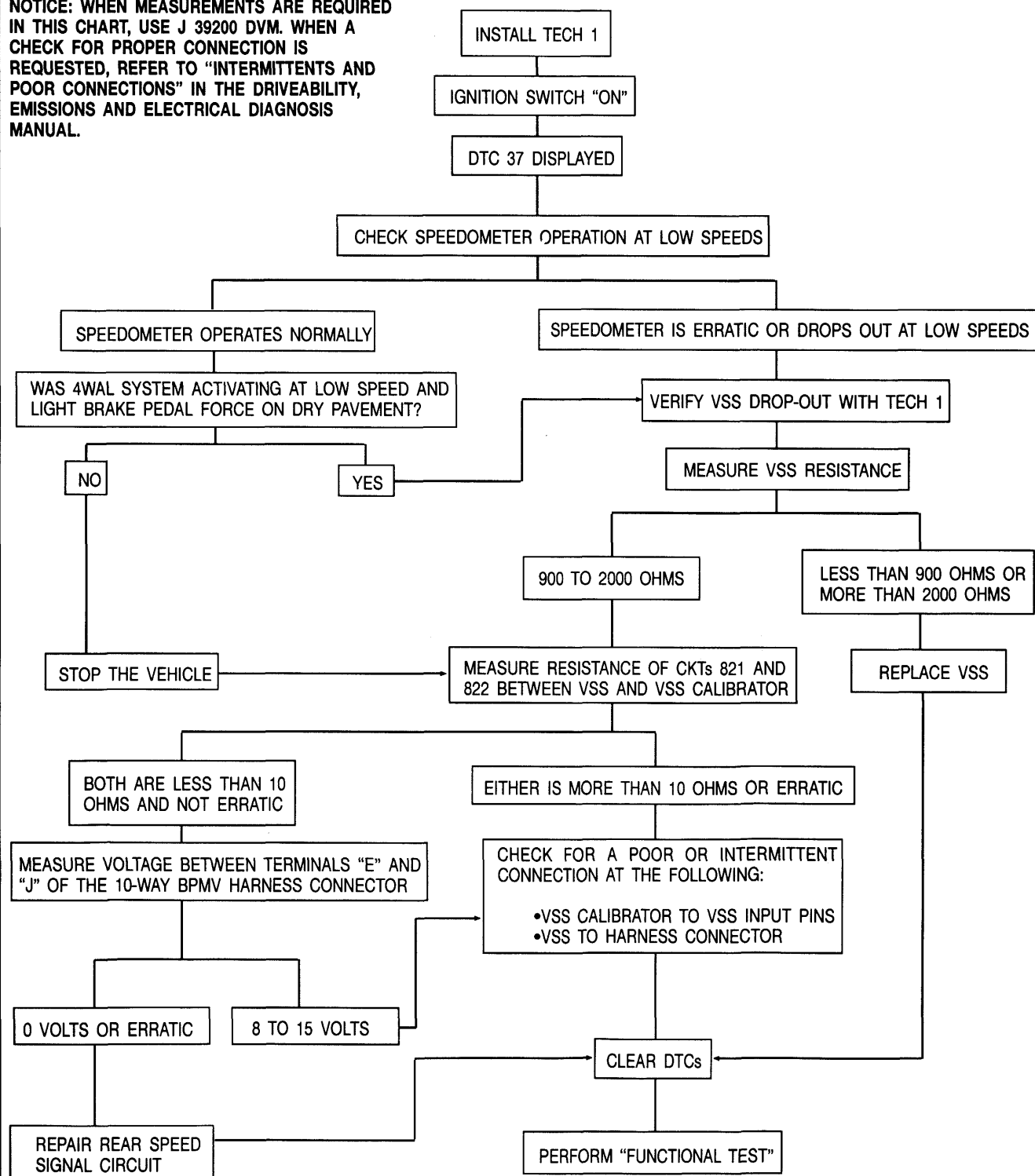
DIAGNOSTIC AIDS:

If the voltage readings are low or varying, the battery, charging system, or intermittent connections could be the cause. Check these areas before replacing any components.

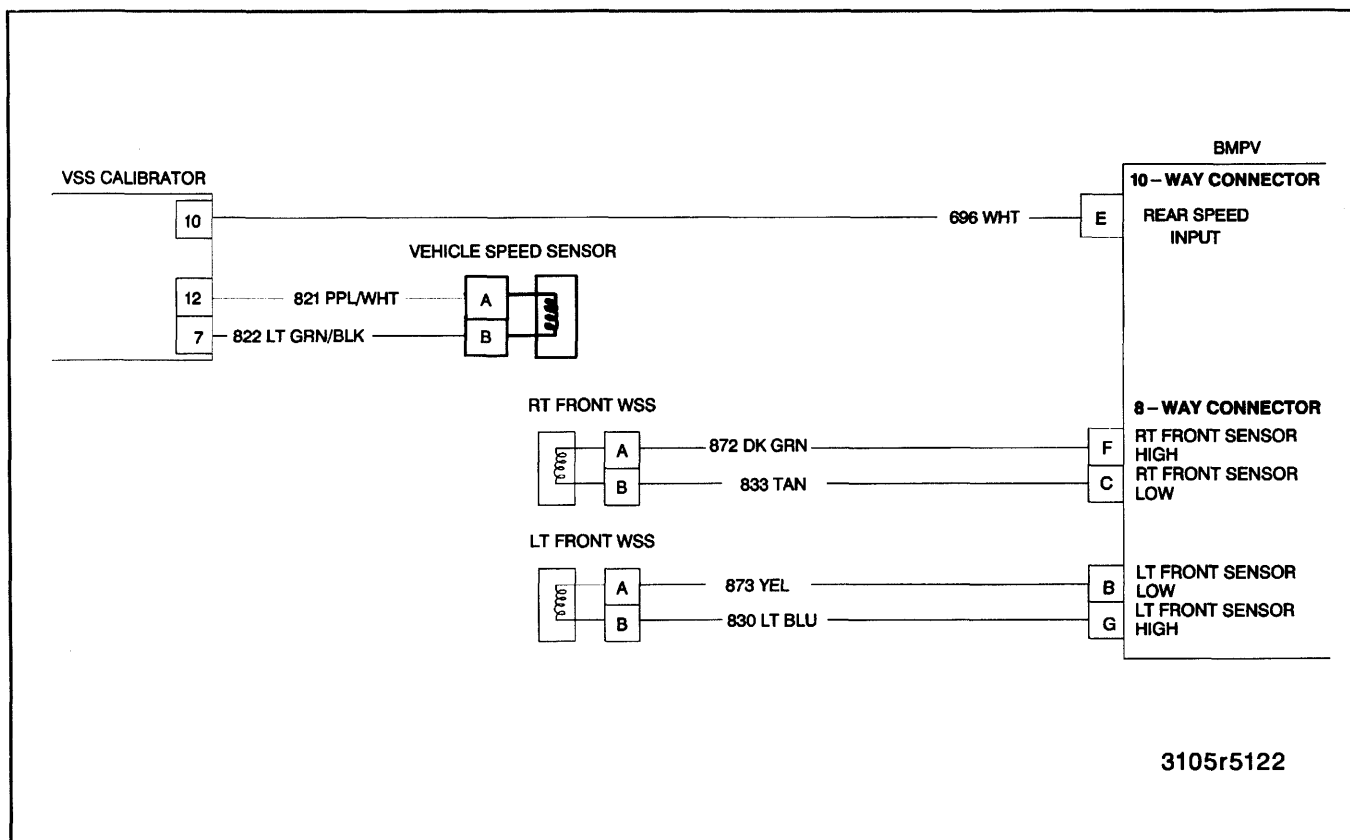
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 37 ERRATIC REAR SPEED SIGNAL

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-38 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 38 WHEEL SPEED ERROR

CIRCUIT DESCRIPTION:

A DTC 38 relates to the BPMV seeing the signal from one sensor at more than double or less than half the frequency of the other sensors for a 12 second duration. This DTC also sets when all three speed inputs differ more than eight percent. The vehicle speed must be over 19 km/h (12 mph) for this DTC to set.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

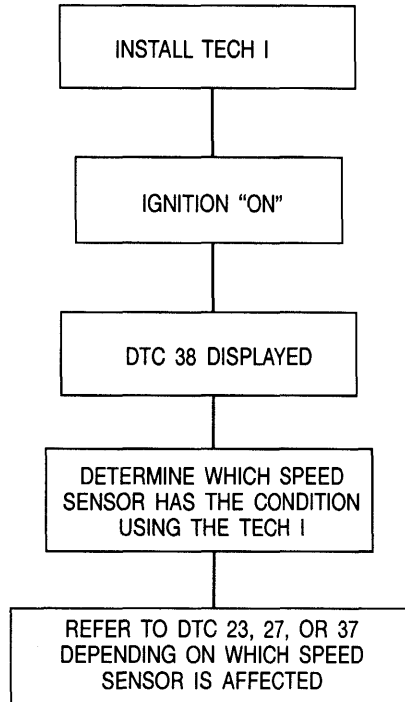
- Verify DTC 38 is stored in memory.
- Check all speed sensor outputs using the Tech 1.
- Refer to "Erratic Sensor" chart 23, 27, or 37.

DIAGNOSTIC AIDS:

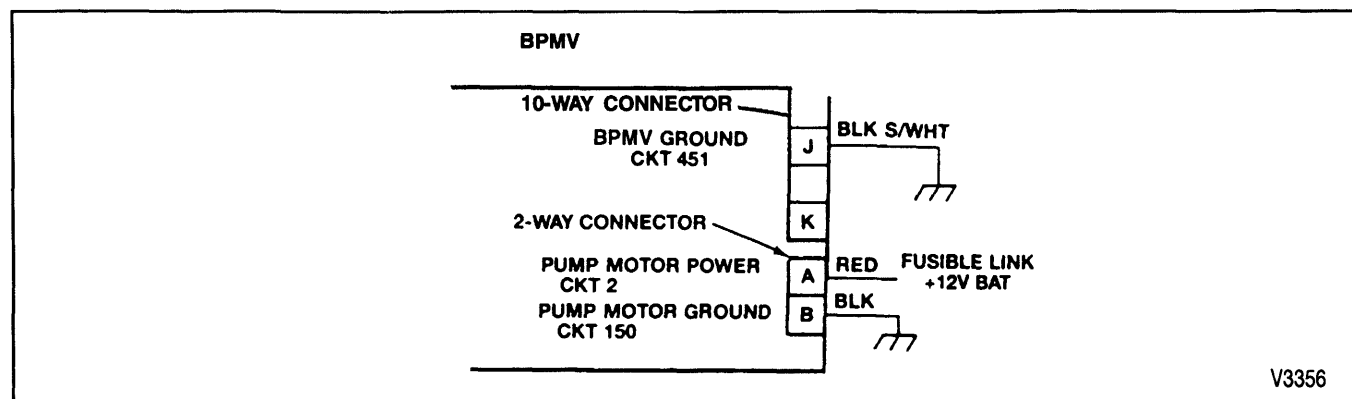
The following could set this DTC:

- Three or four **significantly** different size tires on the vehicle.
- Wrong VSS calibrator and different front wheel sizes.
- Wrong number of teeth on the exciter rings.

**DTC 38
WHEEL SPEED ERROR**



5E1-40 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODES 41 THROUGH 54 BPMV CONTROL VALVES

CIRCUIT DESCRIPTION:

DTCs 41 through 54 relates to the isolation and pulse-width modulation valves inside the BPMV. The various DTC numbers indicate either short or open conditions in the solenoids or module. No parts in the BPMV are serviceable. After verifying the DTC is consistent, the BPMV must be replaced.

DIAGNOSTIC AIDS:

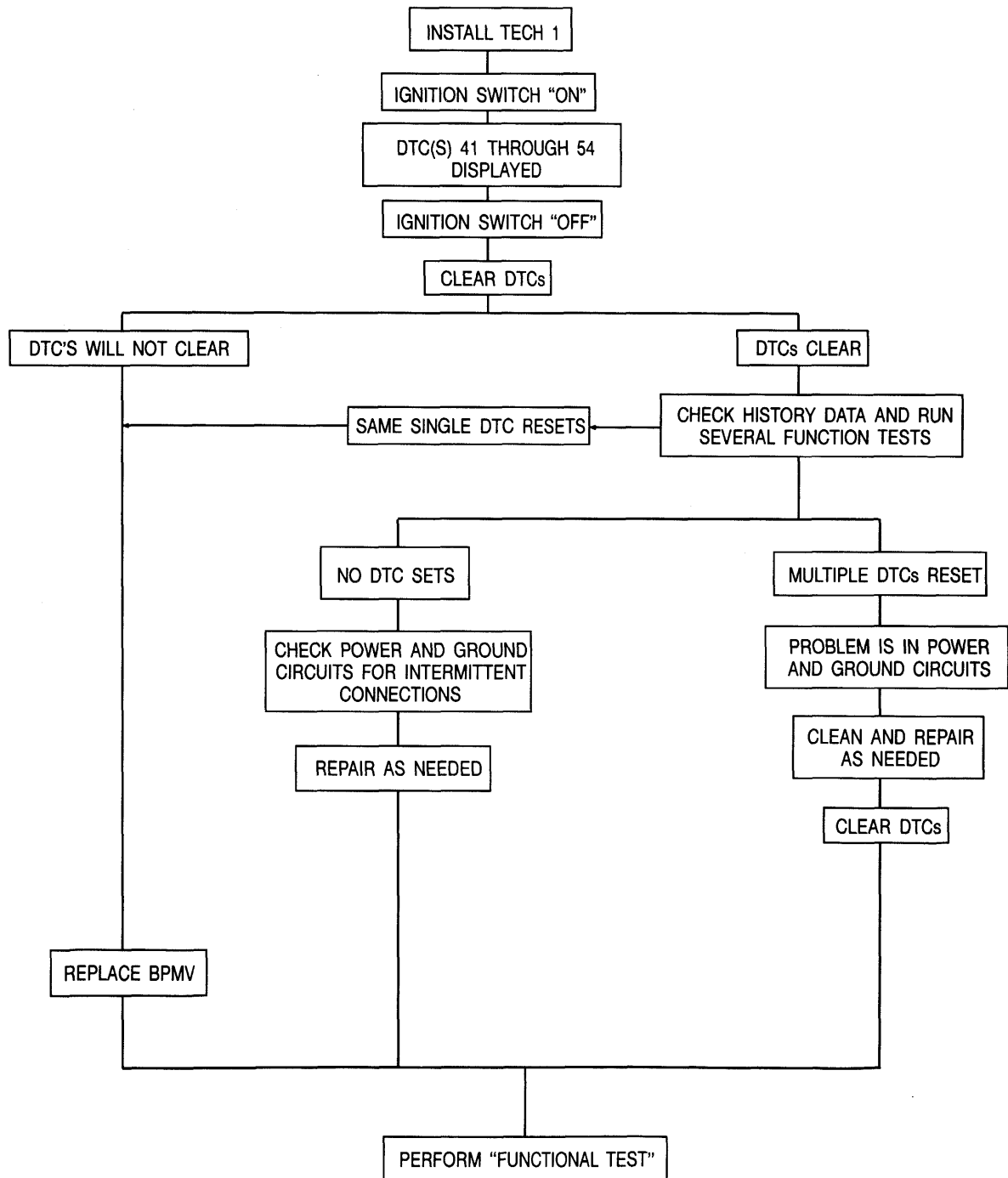
If DTC 41 through 54 sets with other DTCs, check for a poor BPMV ground or power feed.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

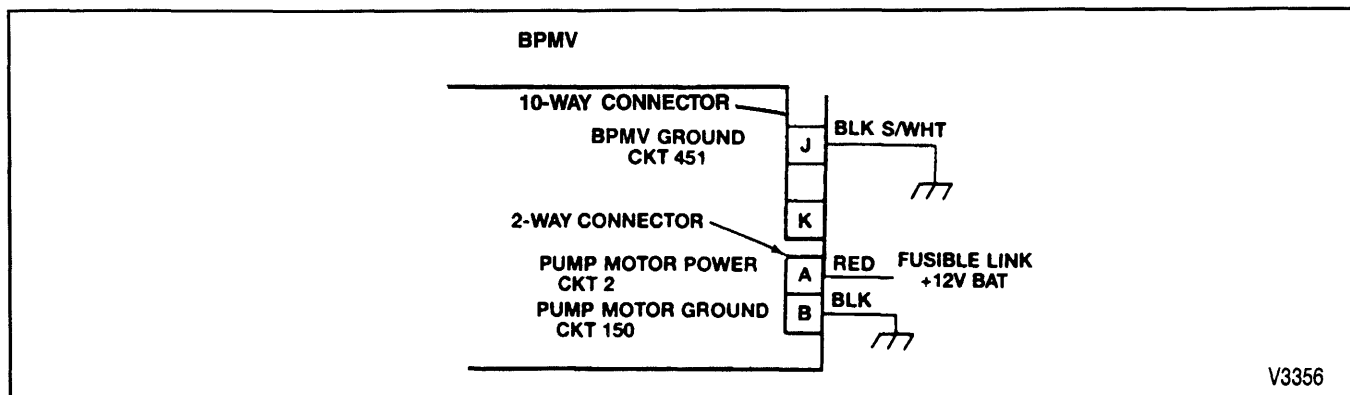
TEST DESCRIPTION:

- Verify a DTC 41 through 54 is stored.
- Clear DTCs.
- Check history and run several function tests using the Tech 1.
- Check BPMV power and ground circuits.

**DTCS 41 THROUGH 54
BPMV CONTROL VALVES**



5E1-42 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 65 OR 66 OPEN OR SHORTED PUMP MOTOR RELAY

CIRCUIT DESCRIPTION:

DTCs 65 and 66 relate to the pump motor relay in the BPMV. The relay is located inside the BPMV and cannot be serviced. The BPMV must be replaced if these tests show the relay has failed. These DTCs can be set by poor power and ground at the 2-way connector or applying the brakes during an erratic speed signal.

TEST DESCRIPTION:

- Check the various conditions that can cause these DTCs.
- Check if DTCs will clear.
- Check if DTC resets after several function tests with the Tech 1.

DIAGNOSTIC AIDS:

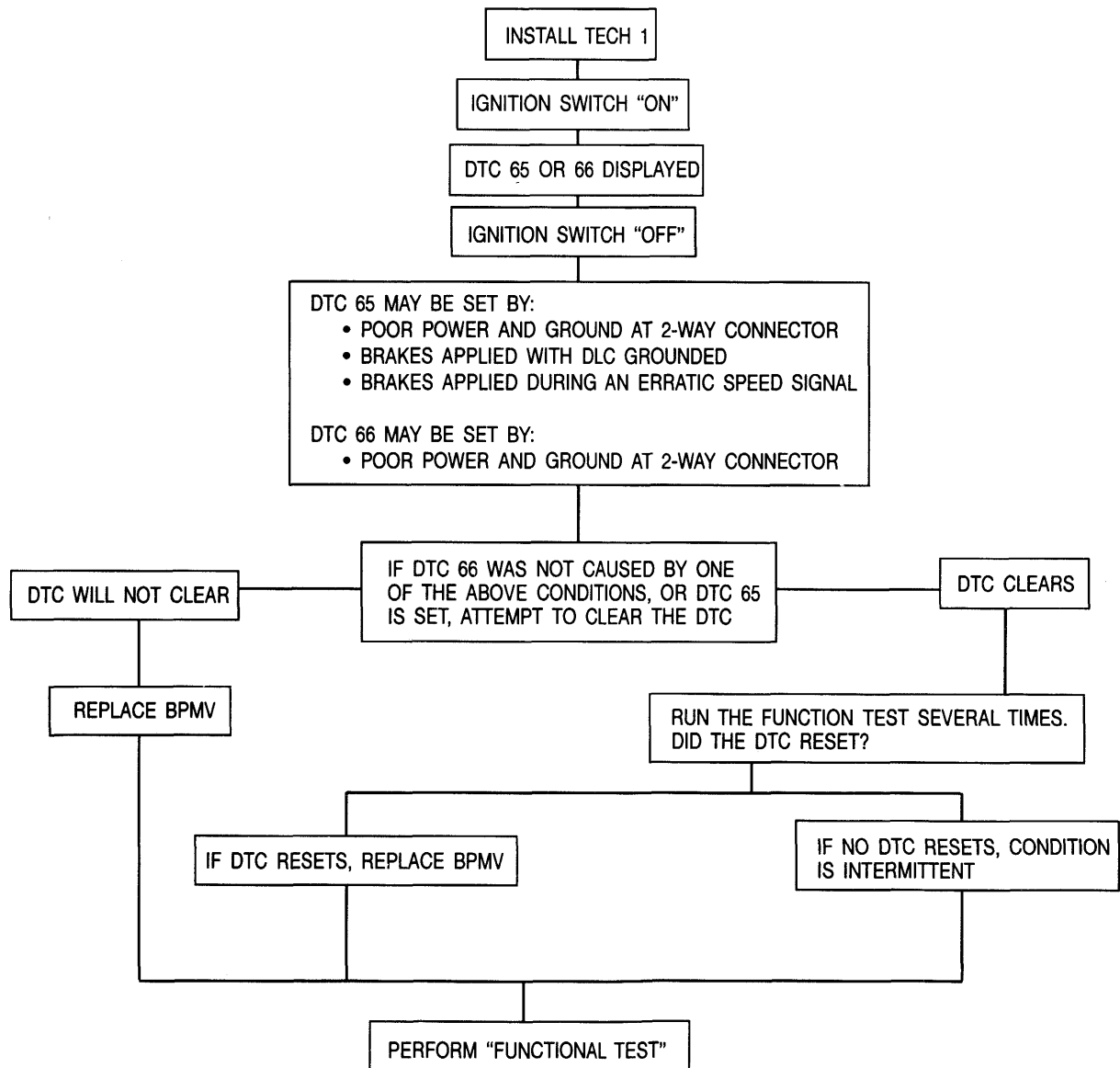
A DTC 65 relates to the 12-volt side of the two-way connector.

If DTC 65 appears with other DTCs, first repair the other DTCs, clear DTCs, and run three function tests with the Tech 1. If DTC 65 resets, refer to this diagnostic chart.

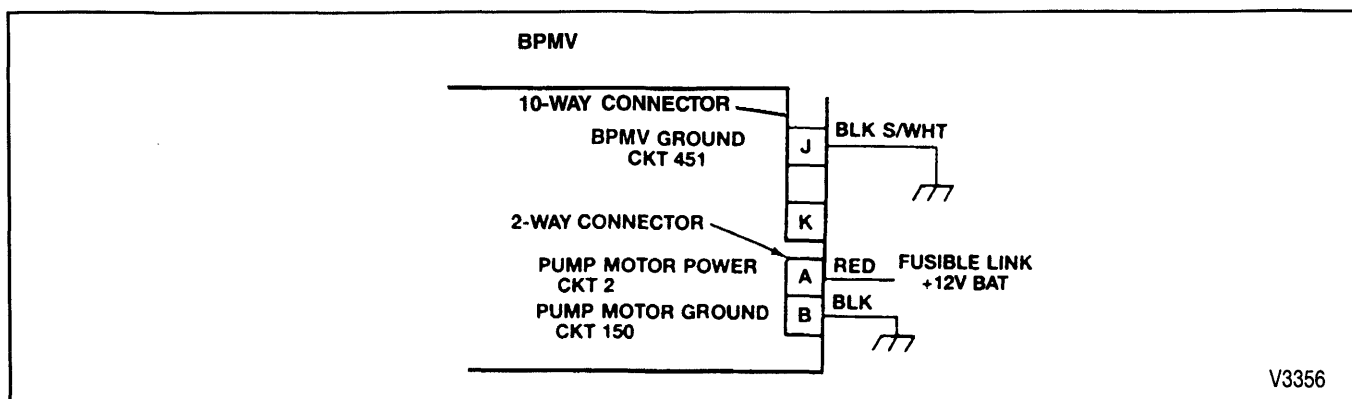
If a DTC 66 sets with other DTCs, check for a poor ground in the two-way connector harness.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

**DTC 65 OR 66
OPEN OR SHORTED PUMP MOTOR RELAY**



5E1-44 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 67 OPEN MOTOR CIRCUIT OR SHORTED BPMV OUTPUT DIAGNOSTIC TROUBLE CODE 68 LOCKED MOTOR OR SHORTED MOTOR CIRCUIT

CIRCUIT DESCRIPTION:

DTCs 67 and 68 relate to the pump motor and circuit in the BPMV. The motor and pumps are integral with the BPMV and cannot be serviced. The BPMV must be replaced if these tests show the motor or internal circuitry have failed. These DTCs can be caused by poor power and ground at the 2-way connector or motor harness on the BPMV.

TEST DESCRIPTION:

- Check the voltage and ground circuits at the BPMV 2-way connector.

- Check the motor harness and connector for damage.
- Check CKT 450 for a good ground.
- Check if DTC returns after being cleared.

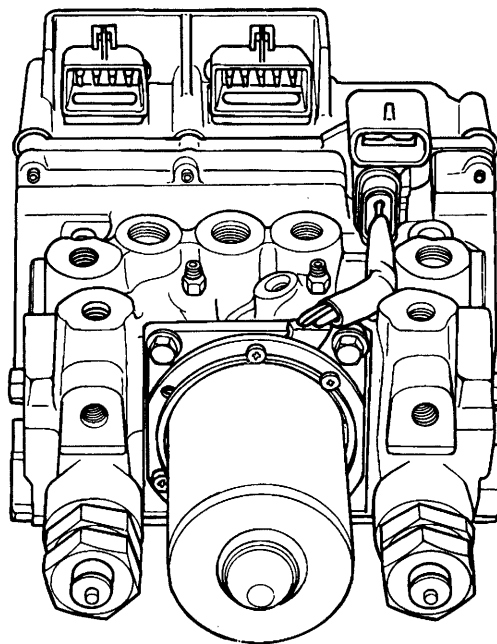
DIAGNOSTIC AIDS:

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

```

graph TD
    A[INSTALL TECH 1] --> B[IGNITION "ON"]
    B --> C[DTC 67 OR 68 DISPLAYED]
    C --> D[IGNITION "OFF"]
    D --> E[CHECK VOLTAGE AT 2 PIN CONNECTOR BETWEEN CKTS 2 AND 150]
    E --> F[9-14 VOLTS]
    E --> G[LESS THAN 9 VOLTS]
    F --> H[CHECK THE CONNECTION WHERE THE MOTOR PLUGS INTO THE BPMV AND THE WIRES BETWEEN THE MOTOR AND THE CONNECTOR]
    H --> I[CONNECTION CLEAN AND TIGHT]
    H --> J[CONNECTION LOOSE, DIRTY, CORRODED, OR WIRE DAMAGED]
    I --> K[CHECK BPMV GROUND CONNECTION (CKT 150)]
    K --> L[CONNECTION CLEAN AND TIGHT]
    J --> M[REPAIR AS NEEDED]
    L --> N[CLEAR DTCS]
    M --> N
    G --> O[CHECK GROUND CKT 150 AND POWER CKT 2. REPAIR AS NEEDED]
    O --> N
    N --> P[DTCS CLEAR]
    N --> Q[DTCS REMAIN]
    P --> R[PERFORM "FUNCTIONAL TEST"]
    R --> S[ ]
    Q --> T[REPEAT CHECKS BEFORE REPLACING BPMV]
    T --> U[REPLACE BPMV]
    U --> S
    S --> R
  
```

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



V3417

DIAGNOSTIC TROUBLE CODES 71 THROUGH 74 BPMV MEMORY ERRORS

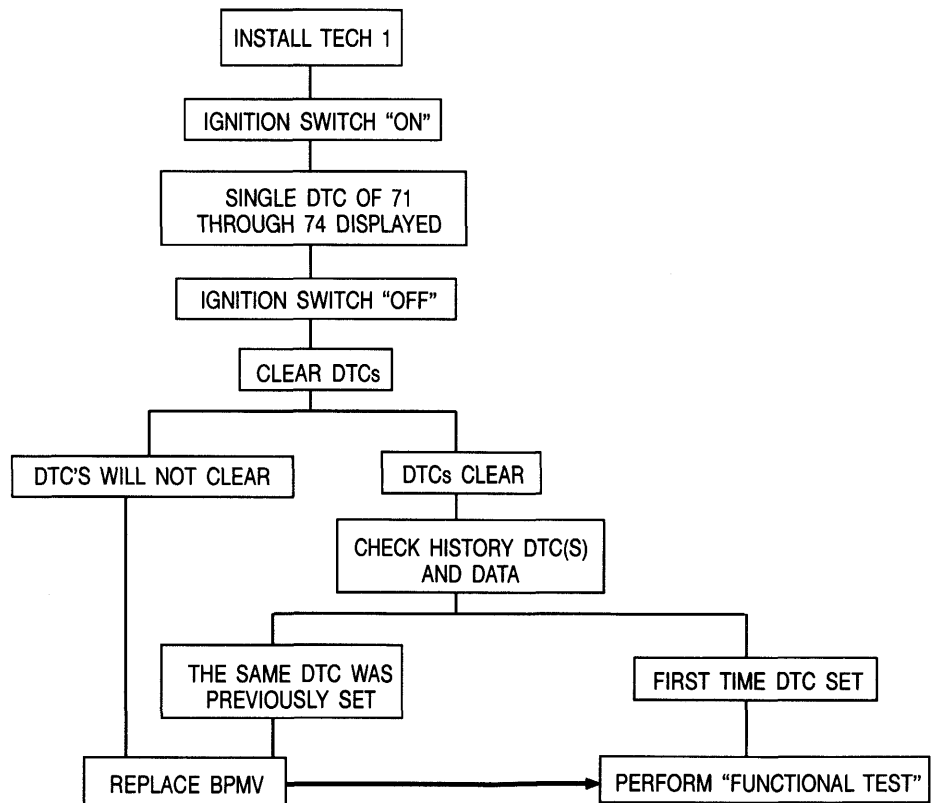
CIRCUIT DESCRIPTION:

DTCs 71 through 74 relate to the module circuitry inside the BPMV. The module is integral with the BPMV and cannot be serviced. The BPMV must be replaced if these tests show the module circuitry has failed.

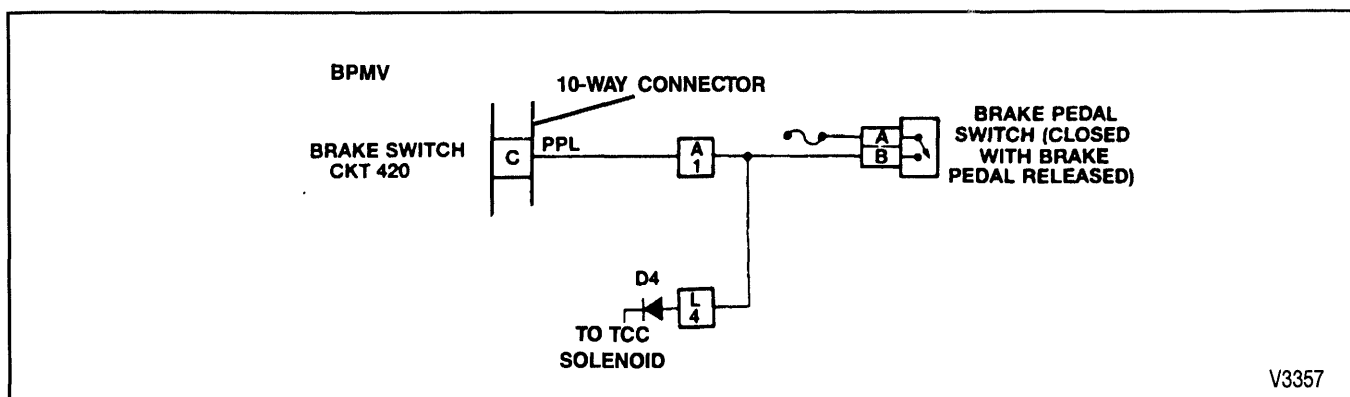
TEST DESCRIPTION:

- Check if BPMV will clear DTCs.
- Check if DTC has been set previously.

**DTCS 71 THROUGH 74
BPMV MEMORY ERRORS**



5E1-48 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 81 BRAKE SWITCH CIRCUIT OPEN OR SHORTED

CIRCUIT DESCRIPTION:

A DTC 81 relates to the BPMV not seeing the brake switch signal from start up until 10 seconds after the vehicle reaches speeds over 56 km/h (35 mph). An indication of an open brake switch circuit is the "ANTILOCK" lamp will turn on during acceleration at 24 km/h (15 mph) and turn off during deceleration at 24 km/h (15 mph). A faulty brake switch or circuit condition in CKT 420 can cause this DTC.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

- Check for a blown "BRAKE" fuse.
- Check brake switch status using the Tech 1.
- Check CKT 420 for looseness or corrosion.

DIAGNOSTIC AIDS:

This DTC could be caused by the driver riding the brake pedal.

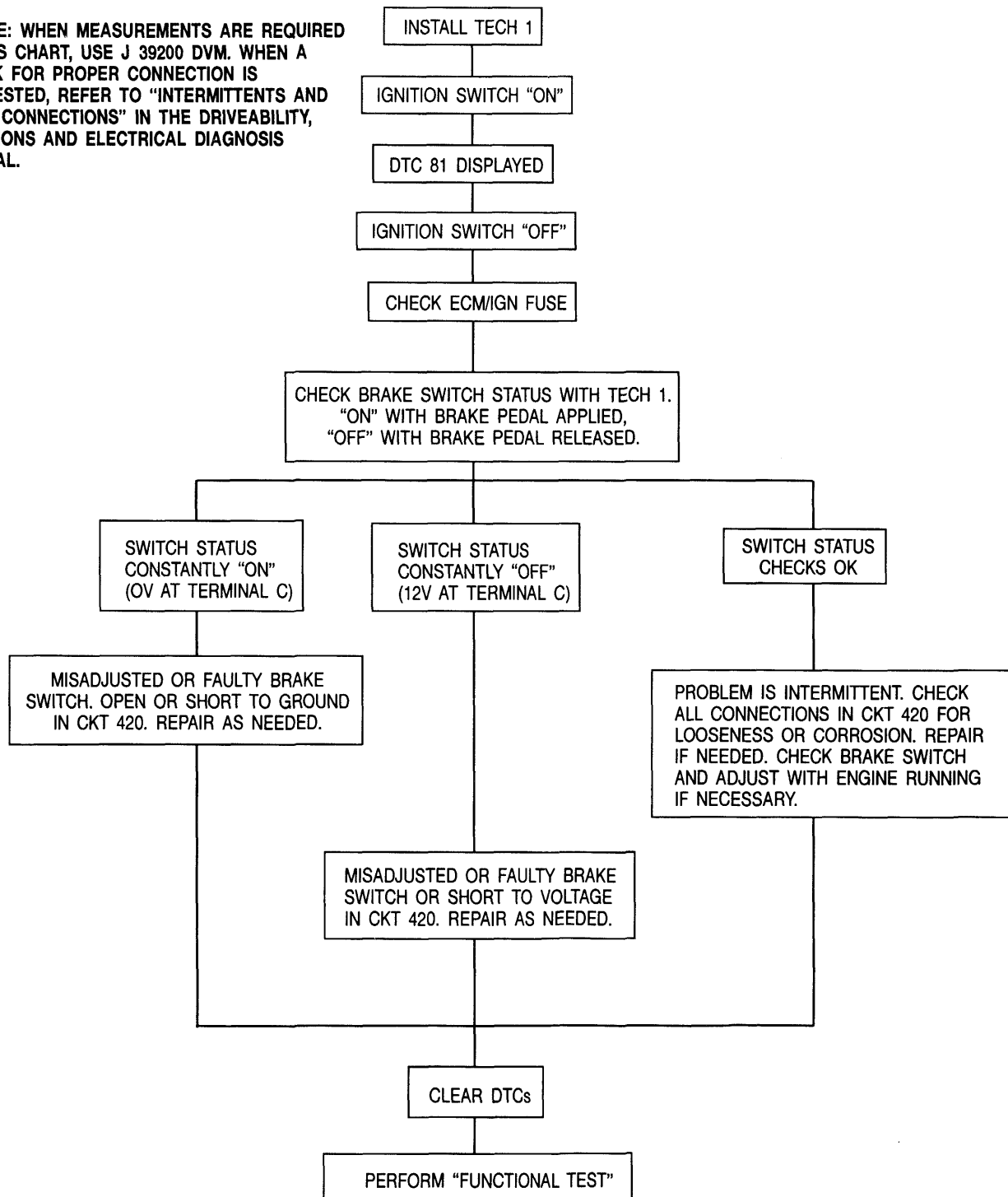
This DTC is a soft fault. The "ANTILOCK" lamp will not come on until the vehicle reaches 24 km/h (15 mph).

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

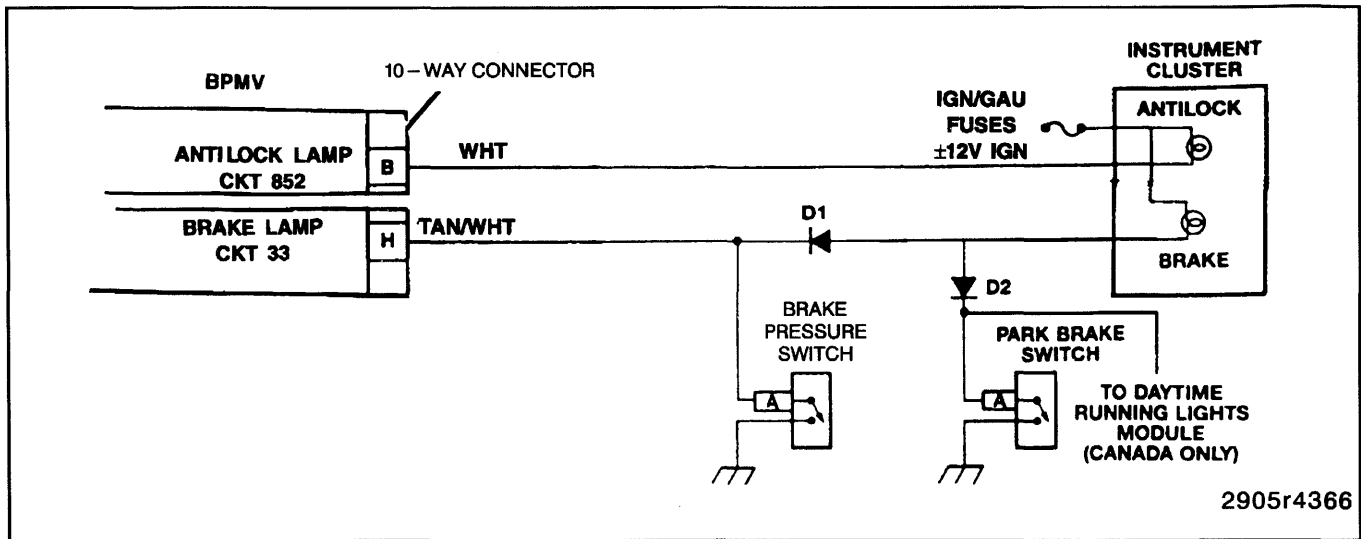
DTC 81

BRAKE SWITCH CIRCUIT SHORTED OR OPEN

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E1-50 FOUR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 86 SHORTED ANTILOCK INDICATOR LAMP DIAGNOSTIC TROUBLE CODE 88 SHORTED BRAKE WARNING LAMP

CIRCUIT DESCRIPTION:

DTCs 86 and 88 relate to malfunctions in the "ANTILOCK" and "BRAKE" lamp circuits. When a malfunction occurs in the "ANTILOCK" lamp circuit, the BPMV uses the "BRAKE" lamp in its place.



Important

- Do not replace the BPMV for this DTC. A faulty BPMV will not cause this DTC to set.

TEST DESCRIPTION:

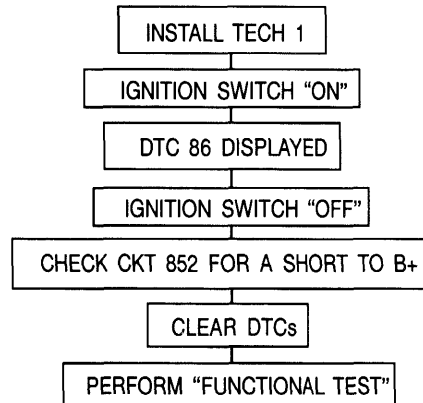
- Check for a short to B+ in either CKT 852 or 33 depending on which lamp malfunctioned.

DIAGNOSTIC AIDS:

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 86

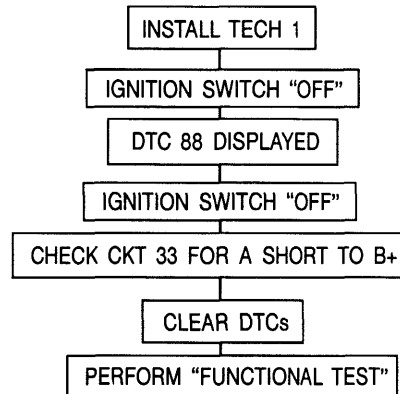
SHORTED ANTILOCK INDICATOR LAMP



C0083

DTC 88

SHORTED BRAKE WARNING LAMP



C0084

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

The 4WAL system is basically maintenance free. When doing work on this system, the following must be observed:

- Before doing welding work on the vehicle with an electric welding unit, turn the ignition switch "OFF" and disconnect the BPMV connectors.
- Do not use a fast charger for starting the engine.
- Disconnect the negative battery cable when fast charging. Refer to SECTION 0A.
- Never disconnect the the battery from the vehicle electrical system with the engine running.
- Make sure all wiring harness connectors are securely connected.
- Always note the routing, position, mounting, and location of all components, wiring, connectors, clips, brackets, brake pipes, etc., when servicing the 4WAL system. Speed sensor wiring, routing, and retention is especially important to help prevent false signals due to electrical noise picked up by the wiring. Proper system operation can only be achieved if the system is restored to its original equipment condition.

The above mentioned items do not cover every possibility, but must be followed when working on 4WAL. When doing service work, become familiar with 4WAL, and how it interrelates with other components on the vehicle.

CHECKING AND ADDING FLUID

For information on checking and adding fluid to the brake hydraulic system, refer to SECTION 5A.

BLEEDING SYSTEM

The 4WAL brake pressure modulator valve (BPMV) should be bled after replacement or if air is trapped in it. Bleeding should not be necessary if the fluid is not contaminated or no air is in the BPMV. There are internal bleed valves on each side of the BPMV that open internal channels. Open the internal bleed valves (item A, figure 9) 1/4 to 1/2 turn before bleeding. Should the module need bleeding, it must be bled after the master cylinder and before the wheel cylinders and calipers.

NOTICE: The ignition switch must be in the "OFF" position or false trouble codes could be set to memory.

Tools Required:

- J 39177 Combination Valve Pressure Bleeding Tool (Three required)
- TK 00000 Tech-1 Scan Tool
- TK 02650 RWAL/4WAL Cartridge Kit or 3000003 Mass Storage Cartridge

You can also use a modified J 35856 Combination Valve Pressure Bleeding Tool in place of J 39177 providing you remove the dimple from it first.



Important

- You can expect to use two quarts of brake fluid to thoroughly bleed the system.
1. Open the internal bleed valves on the sides of the BPMV 1/4 to 1/2 turn each (A).
 2. Install J 39177 on the left high pressure accumulator bleed stem (C) of the BPMV (figure 9).
 3. Install J 39177 on the right high pressure accumulator bleed stem (C) of the BPMV (figure 9).
 4. Install J 39177 on the combination valve (figure 10).
 5. Check the master cylinder reservoir fluid level and fill if needed.
 6. Bleed the brakes as described in SECTION 5.
 7. Close the internal bleed valves.



Tighten

- Internal bleed valves (A) to 7 N.m (60 lbs. in.).
8. Remove the three J 39177 Combination Valve Pressure Bleeding Tools.
 9. Check the master cylinder reservoir fluid level and fill if needed.
 10. With the ignition switch "ON" and the engine off, do six function tests with the Tech-1 scan tool.
 11. Repeat the wheel cylinder and caliper bleed procedure to remove the air that purged from the BPMV during the function tests.

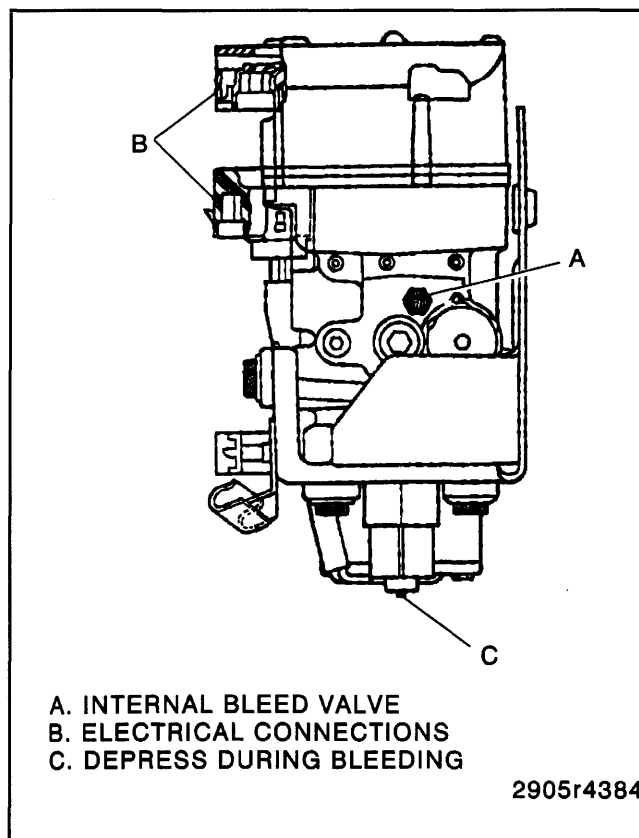


Figure 9—Bleeding the BPMV

12. Apply firm pressure to the brake pedal and evaluate brake pedal feel.
13. Repeat the bleed procedure if needed.
 - Make sure you have a good, hard brake pedal before starting the engine and moving the vehicle.

BRAKE PRESSURE MODULATOR VALVE

↔ Remove or Disconnect (Figures 11 and 12)

1. Electrical connectors from BPMV.
2. Brake pipes from BPMV.
3. Bolts (11).
4. BPMV and bracket assembly.
5. Bolts (12).
6. BPMV (1) from mounting bracket (13).

↔ Install or Connect (Figures 11 and 12)

NOTICE: For steps 2, 4, and 5 refer to "Notice" on page 5E1-1.

1. BPMV to mounting bracket.
2. Six bolts (12).



Tighten

- Bolts (12) to 7 N.m (60 lbs. in.). Over tightening these bolts could result in excessive noise transfer from the BPMV.
3. BPMV and bracket assembly.

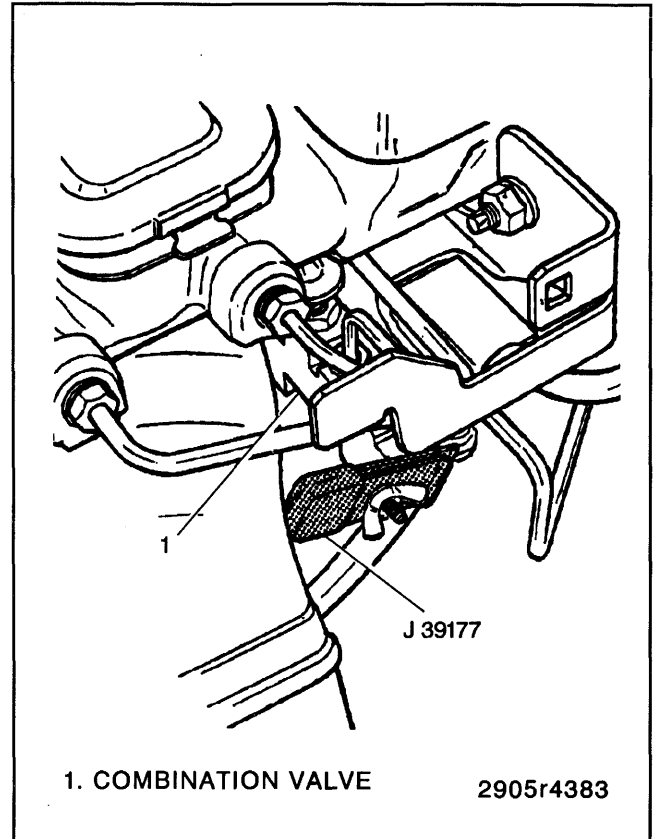


Figure 10—Depressing Combination Valve

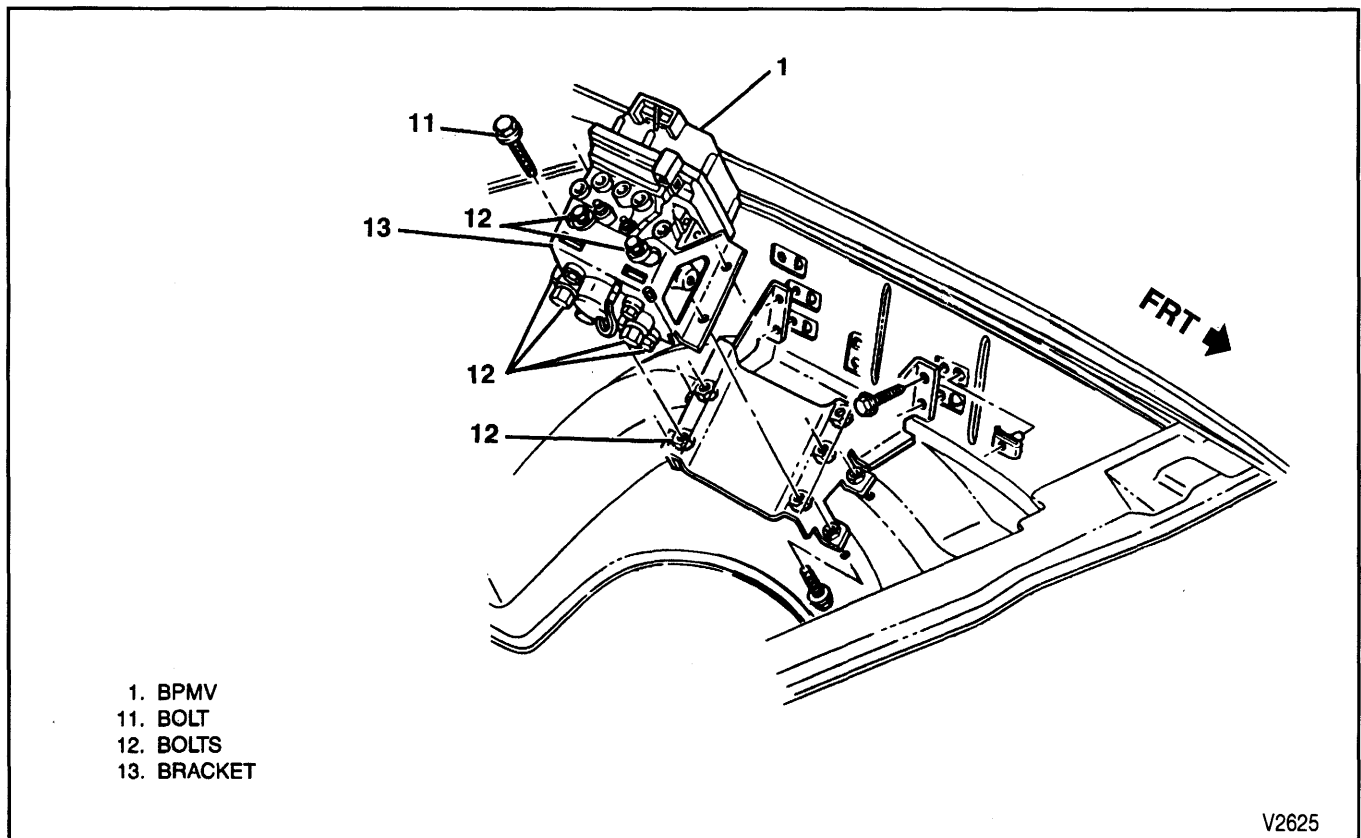


Figure 11—Brake Pressure Modulator Valve Mounting

5E1-54 FOUR WHEEL ANTILOCK BRAKE SYSTEM

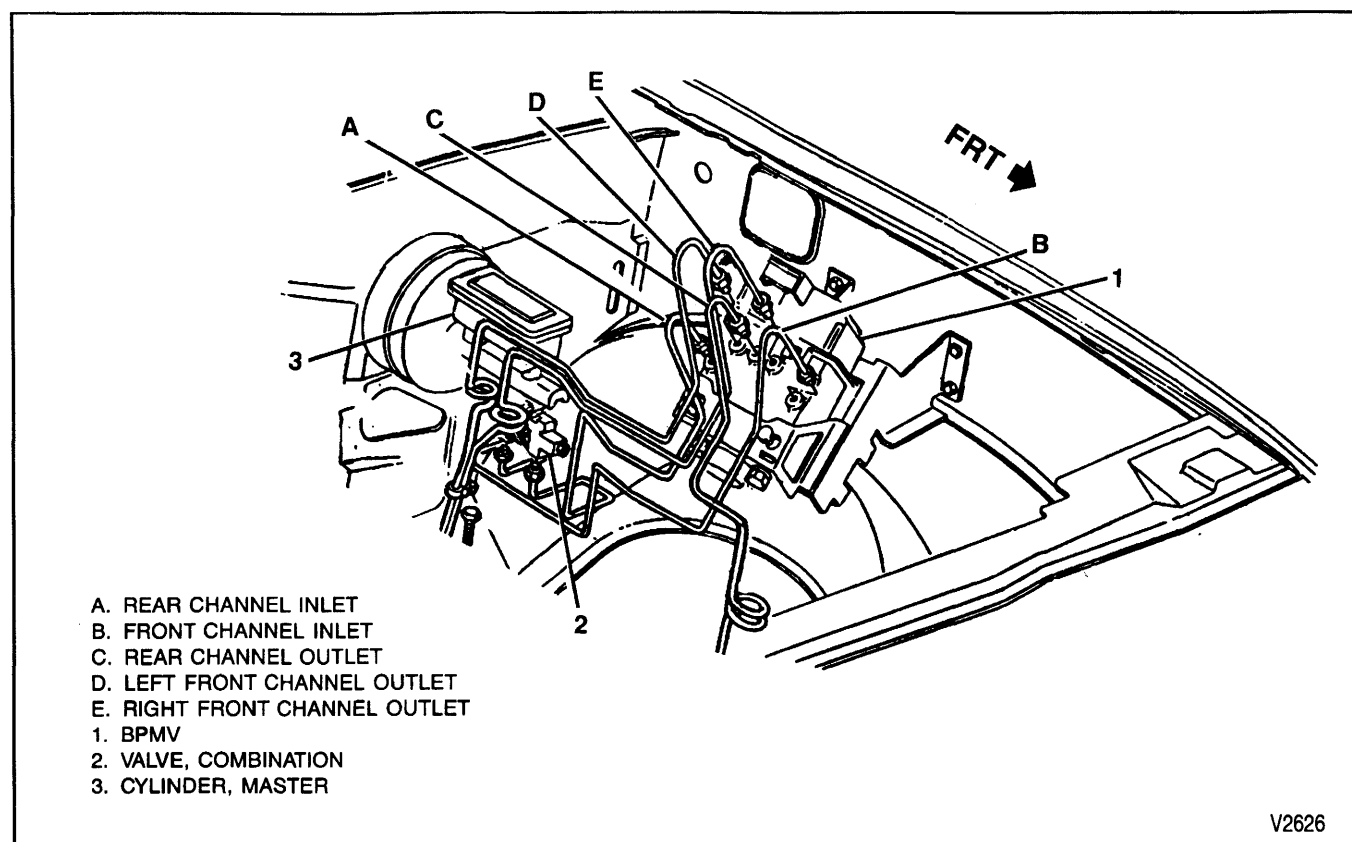


Figure 12—BPMV Brake Line Connections

4. Bolts (11).



Tighten

- Bolts (11) to 27 N·m (20 lbs. ft.).

5. Brake pipes to BPMV.



Tighten

- Brake pipe fittings to 25 N·m (16 lbs. ft.).

6. Electrical connectors to BPMV.

7. Bleed brake system. Refer to "Bleeding System."

FRONT WHEEL SPEED SENSOR

TWO WHEEL DRIVE



Remove or Disconnect (Figure 13)

1. Tire and wheel. Refer to SECTION 3C.
2. Brake caliper. Refer to SECTION 5B1.
3. Hub and rotor. Refer to SECTION 3C.
4. Wheel speed sensor electrical connector.
5. Wheel speed sensor harness clip rivets.
 - Use a 3/16 inch drill.

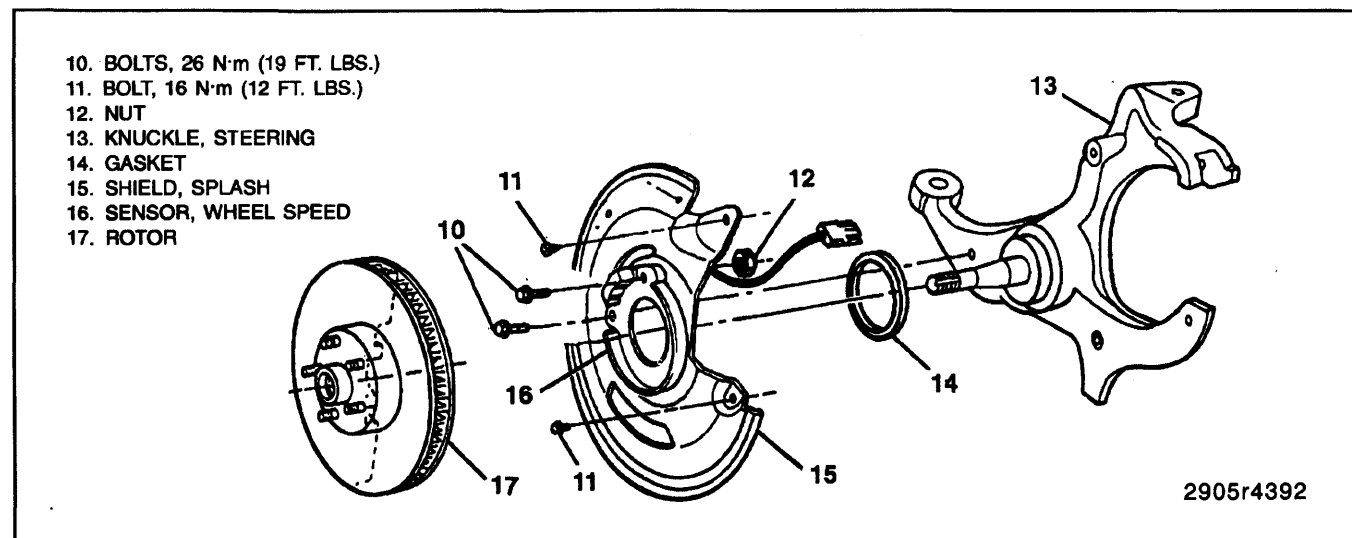


Figure 13—Front Wheel Speed Sensor (2WD)

6. Clips from wheel speed sensor wire.
 - Save clips for new wheel speed sensor.
7. Wheel speed sensor mounting bolts and nut.
8. Splash shield mounting bolts.
9. Wheel speed sensor and splash shield.
10. Splash shield gasket.

Install or Connect (Figure 13)

NOTICE: For steps 3 and 4, refer to "Notice" on page 5E1-1.

1. Splash shield gasket.
2. Wheel speed sensor and splash shield.
3. Splash shield mounting bolts.

Tighten

- Splash shield mounting bolts to 16 N·m (12 lbs. ft.).
4. Wheel speed sensor mounting bolts and nut.

Tighten

- Wheel speed sensor mounting bolts to 26 N·m (19 lbs. ft.).
5. Harness clips on wheel speed sensor wire.
 - Locate clips at paint dots on wire.
 6. Harness clips and 3/16 inch rivets.
 7. Wheel speed sensor electrical connector.
 8. Hub and rotor. Refer to SECTION 3C.
 9. Brake caliper. Refer to SECTION 5B1.
 10. Tire and wheel. Refer to SECTION 3C.

FOUR WHEEL DRIVE

Remove or Disconnect (Figure 14)

1. Tire and wheel.
2. Electrical connector.
3. Sensor wire from clips on upper control arm.
4. Bolt (18).
5. Bolts (15).
6. Sensor (6).

Install or Connect (Figure 14)

1. Sensor (6).

NOTICE: Refer to "Notice" on page 5E1-1.

2. Bolts (15).

Tighten

- Bolts (15) to 15 N·m (11 lbs. ft.)
3. Sensor wire to clips on upper control arm.
 4. Bolt (18).
 5. Electrical connector (16).
 6. Wheel and tire assembly.

FRONT WHEEL SPEED SENSOR TONE WHEELS

For on-vehicle service information, refer to SECTION 4C.

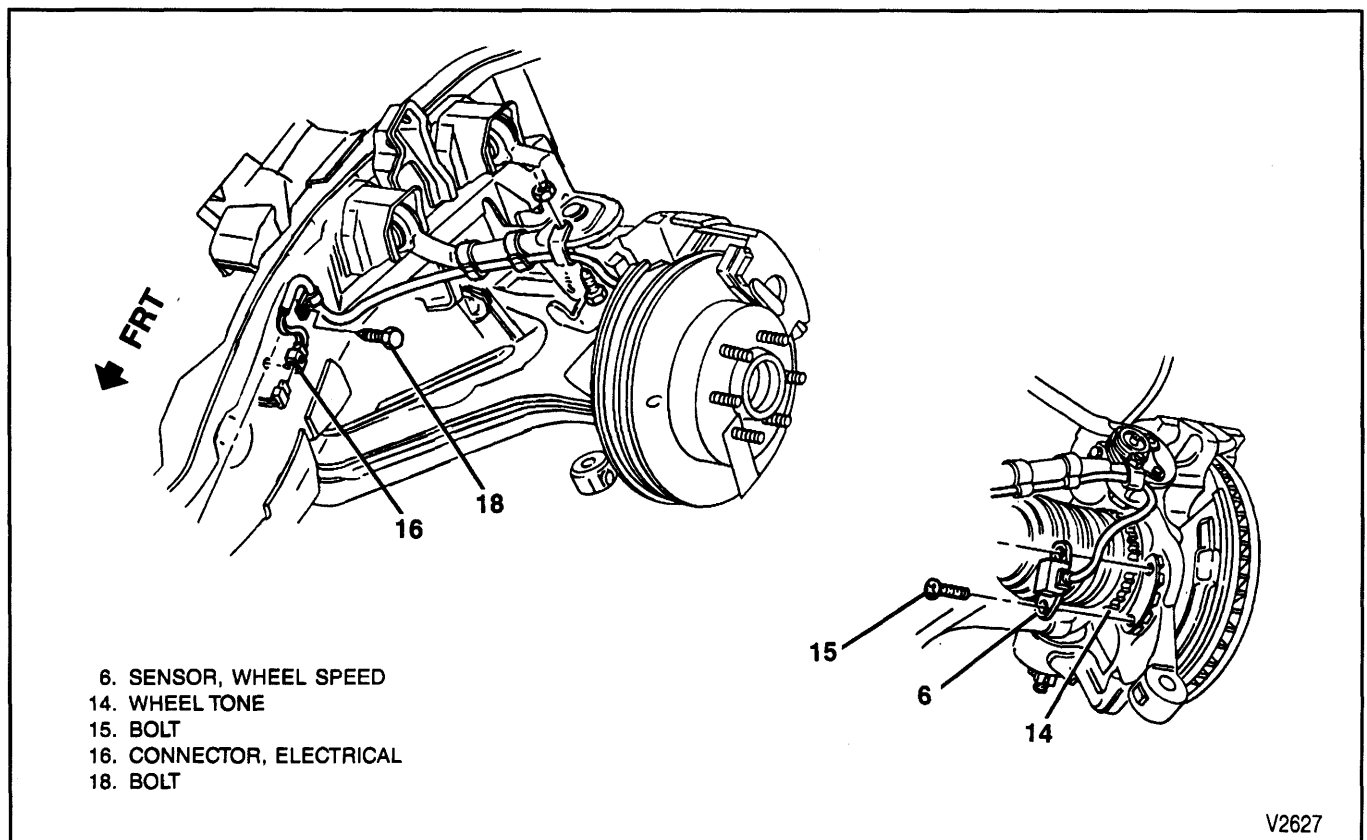


Figure 14—Front Wheel Speed Sensor (4WD)

5E1-56 FOUR WHEEL ANTILOCK BRAKE SYSTEM

VEHICLE SPEED SENSOR

The resistance value of the VSS should be 900 to 2000 ohms. It is located in the left rear of the transmission on 2WD models and the transfer case on 4WD models. For replacement procedures refer to SECTION 7.

VEHICLE SPEED SENSOR CALIBRATOR

For vehicle speed sensor calibrator on-vehicle service, refer to SECTION 8C.

WARNING/INDICATOR LAMPS

For warning/indicator lamp on-vehicle service, refer to SECTION 8C.

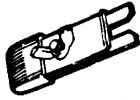
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Lbs. Ft.	Lbs. In.
BPMV to Bracket Bolts	9	—	84
BPMV Bracket Mounting Bolts	27	20	—
Brake Pipe Fittings to BPMV	25	16	—
Brake Pipe Fittings to Combination Valve	20	15	—
Front Wheel Speed Sensor Mounting Bolts (2WD)	26	19	—
Front Wheel Speed Sensor Mounting Bolts (4WD)	10	—	89
Internal Bleed Valves	7	—	60
Splash Shield Mounting Bolts (2WD)	16	12	—
			T2958

SPECIAL TOOLS

1.



J 39177

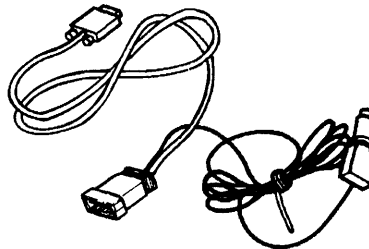
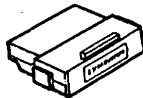
CP

2.

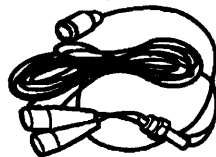


TK 00000

3.



TK 02650 (4 PIECES)
OR
7000001
MASS STORAGE CARTRIDGE



- 1. COMBINATION VALVE PRESSURE BLEEDING TOOL
- 2. TECH-1 SCAN TOOL
- 3. RWAL/4WAL CARTRIDGE KIT

2905r9080

5E1-58 FOUR WHEEL ANTILOCK BRAKE SYSTEM

NOTES

SECTION 5E3

REAR WHEEL ANTILOCK BRAKE SYSTEM

CAUTION: When servicing wheel brake parts, do not create dust by grinding or sanding brake linings or by cleaning wheel brake parts with a dry brush or with compressed air. Many earlier model or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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5E3-2 REAR WHEEL ANTILOCK BRAKE SYSTEM

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GENERAL DESCRIPTION

This section covers diagnosis and service procedures for rear wheel antilock brake systems (figure 1). Two different systems are used on these models, rear wheel antilock (RWAL) and zero pressure rear wheel antilock (ZPRWAL). These systems reduce the occurrence of rear wheel lock-up during a severe brake application. They do this by regulating hydraulic pressure in the rear brake lines.

There are two major differences between RWAL and ZPRWAL:

1. The EBCM is different for each system.
2. The method for clearing diagnostic trouble codes is different.

Care must be used when servicing these systems to make sure the correct EBCM and procedure for clearing diagnostic trouble codes are used.

ZPRWAL is used on the 3500 HD model. The ZPRWAL system is used on rear disc brake systems because of the large volume of fluid the disc brake calipers need. The accumulator for this system is much larger than the RWAL system. The electric brake control modules (EBCM) (figure 2) are identical in size and mounting configuration. The only noticeable difference is the color of the electrical connector. **The RWAL EBCM has a black electrical connector and the ZPRWAL EBCM has a gray electrical connector.**

RWAL is used on all models with rear drum brakes except for four wheel antilock (4WAL) applications.

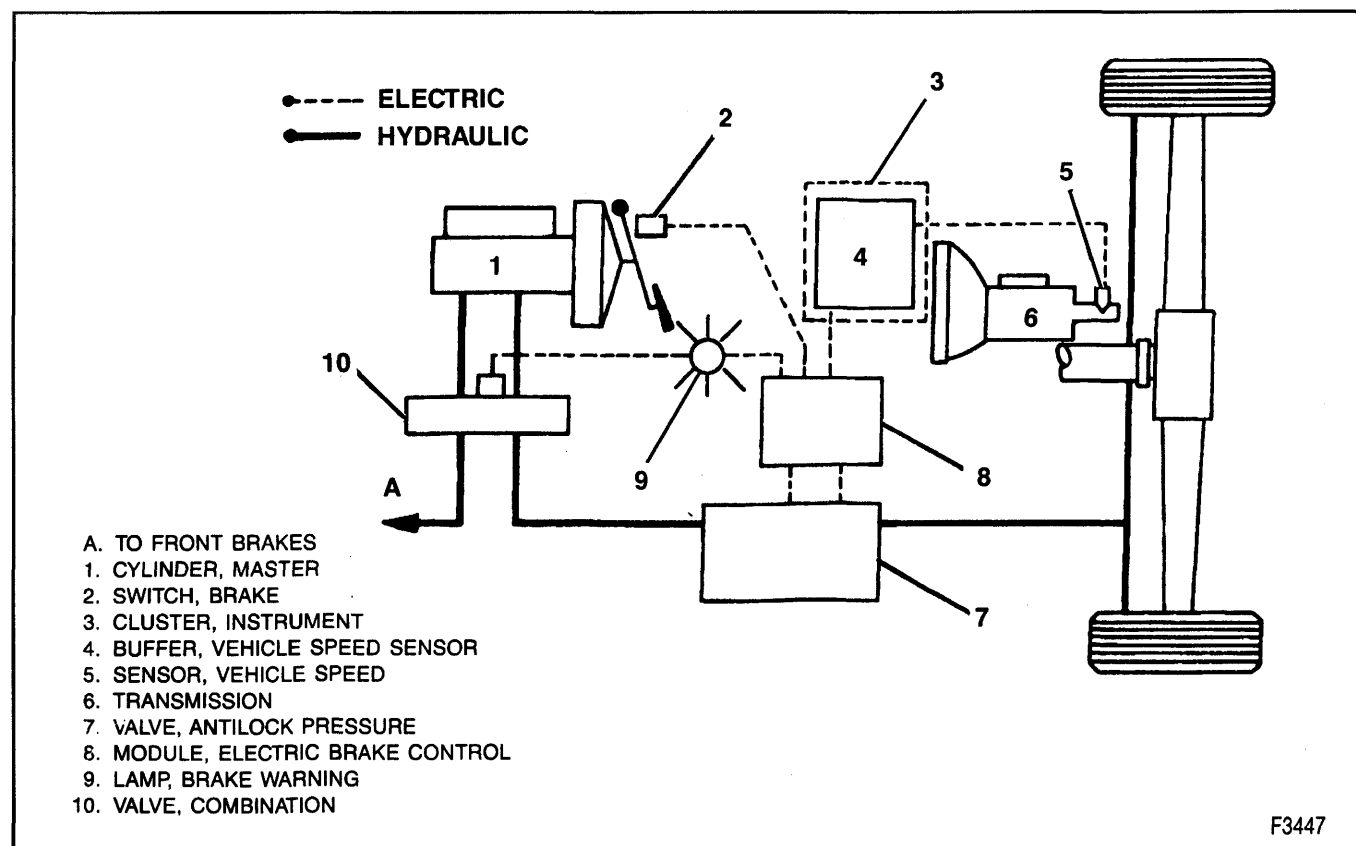


Figure 1—Rear Wheel Antilock Brake System

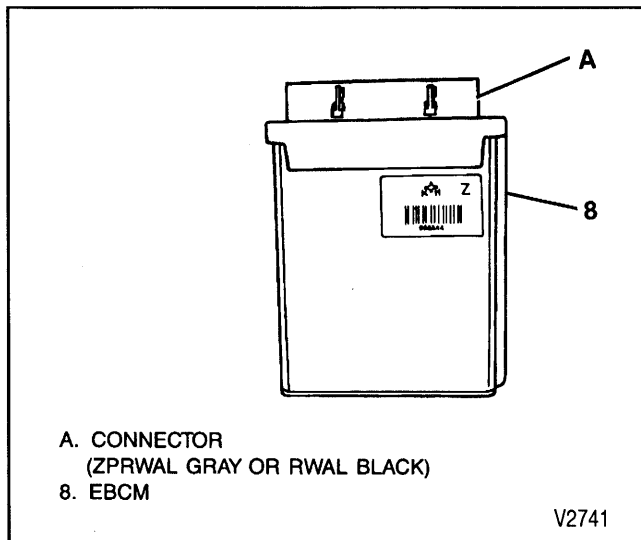


Figure 2—Electric Brake Control Module

ABBREVIATIONS/DEFINITIONS

APV.....	Antilock Pressure Valve
CKT.....	Circuit
DLC.....	Data Link Connector
DTC.....	Diagnostic Trouble Code
DVM.....	Digital Volt Meter
EBCM.....	Electric Brake Control Module
4WD.....	Four Wheel Drive
RWAL.....	Rear Wheel Antilock
VSS.....	Vehicle Speed Sensor
ZPRWAL.....	Zero Pressure Rear Wheel Antilock

BASIC KNOWLEDGE REQUIRED

Before attempting to diagnose the RWAL or ZPRWAL systems you must have a good understanding of electrical system basics and the use of circuit testing tools. Without this basic knowledge it will be difficult to use the diagnostic procedures detailed in this section.

Some electrical basics, basic troubleshooting procedures and hints, and the use of circuit testing tools are discussed in the Driveability, Emissions and Electrical Diagnosis Manual. You will need to know the following:

- **BASIC ELECTRICAL CIRCUITS**
 - The basic theory of electricity, series and parallel circuits, and voltage drops across series and parallel resistor systems.
 - The meaning of volts (voltage), amps (current), and ohms (resistance).
 - What happens in a circuit with an open wire or a wire shorted to ground or battery.
 - How to read and understand a wiring diagram.
- **USE OF CIRCUIT TESTING TOOLS**
 - How to use a digital volt meter (DVM) to measure voltage, current, and resistance.
 - Be aware that when DVM use is requested, the first terminal listed in the check is intended to be connected to the positive (usually red) DVM lead.
 - The operation and capabilities of the Tech 1 scan tool and the RWAL/4WAL cartridge used with it.
 - How to use jumper wires to test circuits.

SYSTEM OPERATION

The purpose of the Rear Wheel Antilock (RWAL) and Zero Pressure Rear Wheel Antilock (ZPRWAL) brake systems is to maintain vehicle stability under severe braking conditions on most road surfaces. The RWAL and ZPRWAL systems monitor the speed of the rear wheels during a braking maneuver. The electric brake control module (EBCM) processes these values to produce command controls to prevent the rear wheels from locking.

BASE BRAKING MODE

During normal braking, the EBCM receives a signal from the stop lamp switch and begins to monitor the vehicle speed line. The isolation valve is open and the dump valve is seated. This allows fluid under pressure to pass through the APV and travel to the rear brake channel. The reset switch does not move because hydraulic pressure is equal on both sides.

ANTILOCK BRAKING MODE

During a brake application the EBCM compares vehicle speed to the program built into it. When it senses a rear wheel lockup condition, it operates the antilock pressure valve to keep the rear wheels from locking up. To do this the EBCM uses a three step cycle:

- Pressure Maintain
- Pressure Decrease
- Pressure Increase

Pressure Maintain

During pressure maintain the EBCM energizes the isolation solenoid to stop the flow of fluid from the master cylinder to the rear brakes. The reset switch moves when the difference between the master cylinder line pressure and the rear brake channel pressure becomes great enough. If this happens, it grounds the EBCM logic circuit.

Pressure Decrease

During pressure decrease the EBCM keeps the isolation solenoid energized and energizes the dump solenoid. The dump valve moves off its seat and fluid under pressure moves into the accumulator. This action reduces rear pipe pressure preventing rear lockup. The reset switch grounds to tell the EBCM that pressure decrease has taken place.

Pressure Increase

During pressure increase the EBCM de-energizes the dump and isolation solenoids. The dump valve reseats and holds the stored fluid in the accumulator. The isolation valve opens and allows the fluid from the master cylinder to flow past it and increase pressure to the rear brakes. The reset switch moves back to its original position by spring force. This action signals the EBCM that pressure decrease has ended and driver applied pressure resumes.

Accumulator Bleed-Down

When the brake pedal is released, the accumulator spring and piston push the stored fluid back to the master cylinder past a lip seal on the dump valve.

System Self-Test

When the ignition switch is turned "ON," the EBCM performs a system self-test. It checks its internal and external circuit and performs a function test by cycling

5E3-4 REAR WHEEL ANTILOCK BRAKE SYSTEM

the isolation and dump valves. The EBCM then begins its normal operation if no malfunctions are detected.

Brake pedal pulsation and occasional rear tire "chirping" are normal during RWAL or ZPRWAL operation. The road surface and severity of the braking maneuver determine how much these will occur. Since these systems only control the rear wheels, it is still possible to lock the front wheels during certain severe braking conditions.

TIRES AND RWAL

Spare Tire

Using the spare tire supplied with the vehicle will not affect the performance of the RWAL or ZPRWAL systems.

Replacement Tire

Tire size can affect the performance of the RWAL or ZPRWAL systems. Replacement tires must be the same size, load range, and construction on all four wheels.

Speedometer Calibration

The vehicle speed sensor (VSS) buffer must be replaced when the rear axle ratio or tire size is changed. Refer to SECTION 8C.

WARNING LAMP OPERATION

"BRAKE" Lamp

The RWAL system uses the existing "BRAKE" warning lamp in the instrument panel to indicate system operation and malfunctions. The "BRAKE" lamp is also used to show a hydraulic system pressure differential condition and parking brake operation.

Normal Operation

A bulb check occurs each time the ignition switch is turned "ON." The "BRAKE" lamp should light, remain on for about 2 seconds, then turn off. When system malfunctions occur, the "BRAKE" lamp will turn on and stay on until the malfunction is corrected. To determine the specific cause of a malfunction, refer to "Functional Test."

The "BRAKE" lamp will also light when the parking brake is applied or the combination valve switch is activated. Do not confuse these functions with an RWAL system malfunction.

SYSTEM COMPONENTS

ELECTRIC BRAKE CONTROL MODULE

The electric brake control module (EBCM) mounts to a bracket next to the master cylinder. It contains a microprocessor and the software for system operation. During a severe brake application the EBCM controls the antilock pressure valve (APV) to prevent the rear

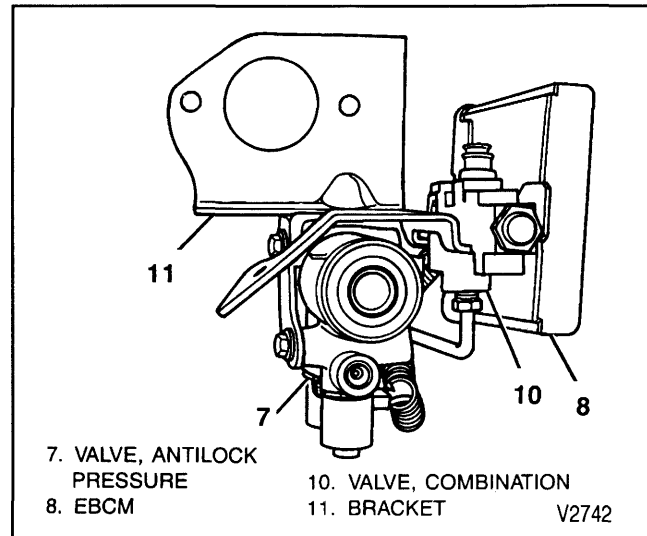


Figure 3—Antilock Pressure Valve and EBCM

wheels from locking up. The EBCM receives input signals from the vehicle speed sensor (VSS) buffer, stop lamp switch, and front axle switch on 4WD applications.

NOTICE: Be sure to use the correct EBCM for the system being serviced. The 3500 HD uses the ZPRWAL EBCM with the gray electrical connector. All other models use the RWAL EBCM with the black electrical connector. Failure to use the correct EBCM will result in a system malfunction.

ANTILOCK PRESSURE VALVE

The antilock pressure valve (APV) mounts to the combination valve under the master cylinder. The APV has an isolation valve to maintain or increase hydraulic pressure, a dump valve to reduce hydraulic pressure, and an accumulator to store brake fluid during the dump cycle. The EBCM uses the APV to control hydraulic pressure in the rear brake pipes. (figure 3)

VEHICLE SPEED SENSOR

The vehicle speed sensor (VSS) is located in the left rear of the transmission on two-wheel drive models and on the transfer case for four-wheel drive models. The VSS produces an AC voltage signal that varies in frequency according to the output shaft speed. The resistance value of the VSS winding should be 900 to 2000 ohms.

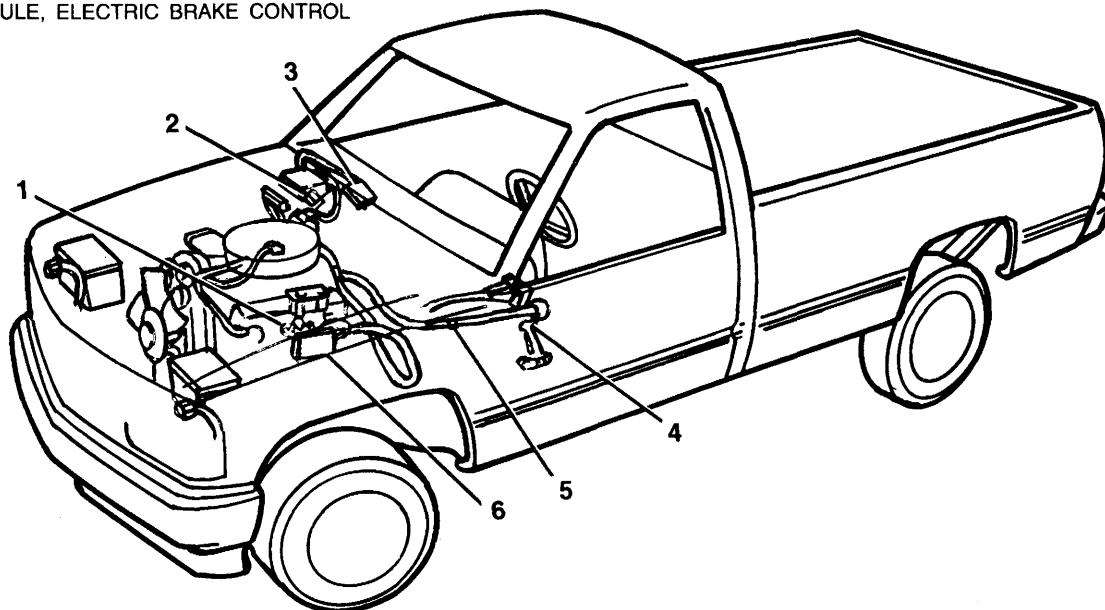
VEHICLE SPEED SENSOR BUFFER

The VSS sends its signal to the vehicle speed sensor (VSS) buffer located behind the instrument panel storage compartment. The VSS buffer changes the AC sine-wave signal from the VSS to a DC square-wave signal. If the axle ratio or tire size is changed, it will be necessary to replace the VSS buffer. Refer to "Speedometer Calibration."

COMPONENT LOCATION VIEWS

For component location views, refer to figure 4.

1. VALVE, ANTILOCK PRESSURE
2. CONNECTOR, ENGINE HARNESS
3. BUFFER, VEHICLE SPEED SENSOR
4. SENSOR, VEHICLE SPEED
5. SWITCH, STOP LAMP
6. MODULE, ELECTRIC BRAKE CONTROL



V3106

Figure 4—RWAL Component Location Views

DIAGNOSIS

DIAGNOSTIC PROCESS

Before beginning diagnosis on the RWAL or ZPRWAL systems, you need a detailed description of when the condition occurred from the owner. This information can be useful in duplicating the condition. Always begin diagnosis with a visual inspection of all connectors, wiring, wire routing and retention, and system components. Many times a disconnected or loose connector, blown fuse, corroded terminal, or misrouted wire is the cause of a malfunction.

If a visual inspection does not reveal the cause of a malfunction, perform the Functional Test in this section. **Always start with the Functional Test.** This is a critical step in the quick and accurate diagnosis of any malfunction. It will direct you to the specific system area that is malfunctioning and verify that the diagnostic system is functioning properly. Correct system diagnosis cannot be ensured without starting diagnosis with the Functional Test.

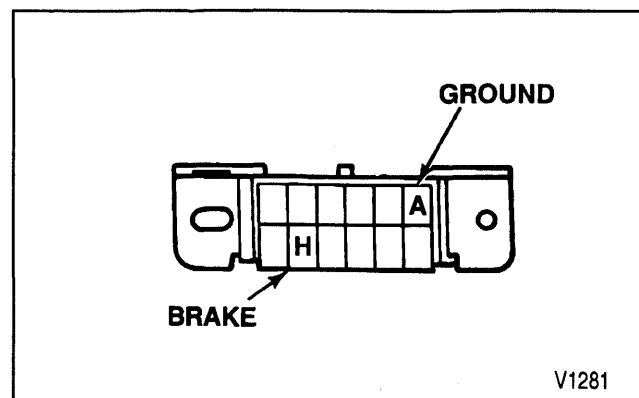
SELF-DIAGNOSTICS

The EBCM performs self-diagnostics and can detect and often isolate system failures. When a malfunction is detected, the EBCM sets a diagnostic trouble code (DTC) that represents the malfunction, turns on the BRAKE lamp (in most instances), and will disable RWAL functions as long as the BRAKE lamp remains on.

The EBCM performs an automatic self-test when the ignition switch is turned to the "ON" position. The EBCM cycles each valve to check component operation. If it detects an error, it sets a DTC as described above.

DISPLAYING DIAGNOSTIC TROUBLE CODES

Diagnostic trouble codes (DTCs) can be displayed using the Tech 1 scan tool or by manually grounding the data link connector (DLC) (figure 5). Ground terminal "H" to terminal "A" of the DLC and count the "BRAKE" lamp flashes. The terminals must be ground-



V1281

Figure 5—Data Link Connector (DLC)

5E3-6 REAR WHEEL ANTILOCK BRAKE SYSTEM

ed for about 20 seconds before the DTC will begin to flash. Count the number of short flashes starting from the long flash. Include the long flash as a count. Sometimes the first count sequence will be short. However, subsequent counts will be accurate. If a soft DTC is stored, only the last recognized DTC will be retained and displayed on the Tech 1.



Important

- Manual grounding should only be done when the "Brake" lamp is on.

NOTICE: DTCs 6, 9, and 10 will only turn the "Brake" lamp on while the fault exists. These are soft faults and can only be read with the Tech 1 scan tool. Do not manually ground terminal "H" to terminal "A" of the DLC if the "BRAKE" lamp is not on. Grounding the DLC with the "BRAKE" lamp off will set a false DTC 9. This will turn the "BRAKE" lamp on and disable the antilock system.

CLEARING DIAGNOSTIC TROUBLE CODES

ZPRWAL (30 SERIES HD MODELS)

The following procedure must be used to clear DTCs on vehicles with the ZPRWAL system.

1. Turn the ignition switch "OFF."
2. Pull the Stop/Hazard fuse.
3. Turn the ignition switch "ON."
 - If a DTC is stored, soft or hard, the "BRAKE" lamp will be on.
4. Do the following at the DLC.
 - A. Ground pin A to H for one second.
 - B. Remove the ground for one second.
 - C. Again ground pin A to H for one second.
 - D. Remove the ground.
5. The "BRAKE" lamp should turn off.
6. Turn the ignition switch "OFF."
7. Replace the Stop/Hazard fuse.
8. Verify no DTCs are stored.

RWAL (ALL OTHER MODELS)

To clear DTCs on all other models:

1. Make sure the ignition switch is "OFF."
2. Pull the Stop fuse.
3. Wait 5 seconds.
4. Reinstall the fuse.
5. Verify no DTCs are stored.

INTERMITTENTS AND POOR CONNECTIONS

Most intermittent faults are caused by a faulty electrical connection or wiring, although a sticking relay or solenoid can occasionally be at fault. Refer to "Intermittents and Poor Connections" in the Driveability, Emissions and Electrical Diagnosis Manual for a detailed explanation of how to locate and repair intermittent conditions.

TECH 1 DIAGNOSTICS



Important

- When using the Tech 1 for RWAL system testing, make sure you are using the RWAL/4WAL cartridge that includes the model year you are working on. Refer to the RWAL/4WAL Cartridge or Mass Storage Cartridge Operator's Manual for additional information about the cartridge.

The Tech 1 has 4 test modes for diagnosis of the RWAL systems. These test modes are:

- Mode F1: Function Test
This test mode is used to perform a functional test of the system. The Tech 1 will simulate an acceleration and deceleration signal that causes the EBCM to cycle the RWAL system. If the EBCM stores a DTC during the test, the Tech 1 will display it at the end of the test. If a DTC is set before you begin the test, the Tech 1 will display the DTC and you will not be able to continue until the DTC is cleared.
- Mode F2: Trouble Code
This mode allows you to access DTCs and offers some diagnostic information on the DTCs.
- Mode F3: Miscellaneous Test
This mode allows you to do specialized testing of the VSS Buffer (DRAC) and stop lamp switch (brake switch).
- Mode F4: VSS Monitor
This mode allows you to monitor the vehicle speed signal as the EBCM sees it.

MODE F3 - MISCELLANEOUS TEST

F0: DRA Check

This mode does not apply to any 1994 models.

F1: Brake Switch Test

This test allows you to determine if there is a malfunction in the stop lamp (brake) switch circuit. On 4WD vehicles, this mode will also allow you to check the front axle and transfer case switched circuits.

1. Select F3: Misc. Tests from main menu.
2. Select F1: Brake Switch Test.
3. Complete the test by following the direction of each screen.

MODE F4 - VSS MONITOR

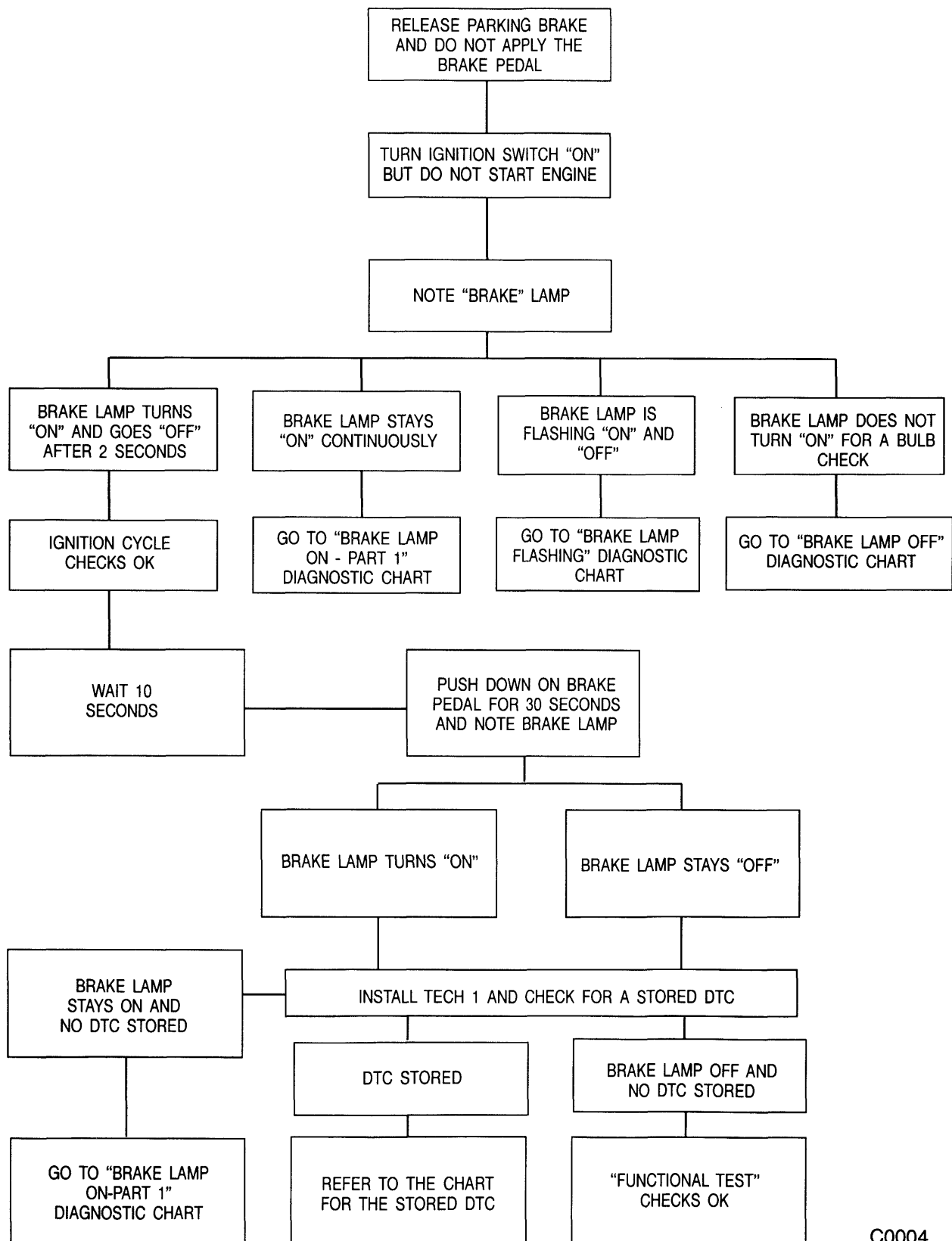
The VSS monitor mode allows you to see the speed signal as the EBCM sees it. This can help you determine if a malfunction relates to the speed signal.

1. Select F4: VSS Monitor from main menu.
2. Speed will be displayed MPH and KPH.

DIAGNOSTIC CHARTS

- Refer to the Functional test as a starting point for all diagnosis. Failure to perform the functional test may result in extended diagnostic time, incorrect diagnosis, and incorrect parts replacement. Refer to figures 6 and 7 for the wiring diagram and connector face views. Diagnostic charts for symptom diagnosis and DTCs follow.

FUNCTIONAL TEST

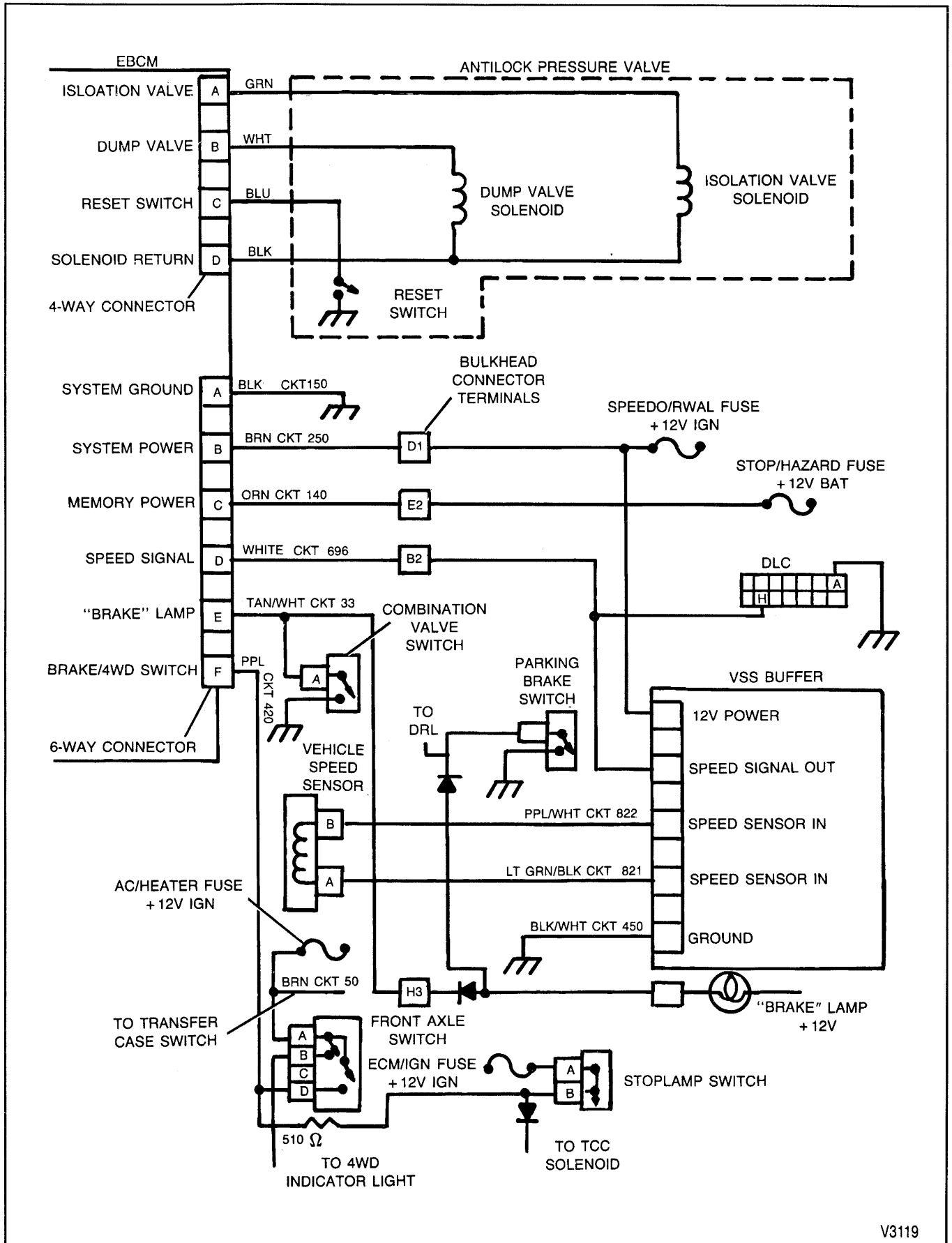


5E3-8 REAR WHEEL ANTILOCK BRAKE SYSTEM**DIAGNOSTIC TROUBLE CODE
AND SYMPTOM TABLE**

Diagnostic Trouble Code	Description/Symptom	Page #
—	Brake Lamp On - Part 1	5E3-11
—	Brake Lamp On - Part 2	5E3-12
—	Brake Lamp On - Part 3	5E3-13
—	Intermittent Brake Lamp	5E3-14
—	Brake Lamp Flashing	5E3-15
—	Brake Lamp Off	5E3-16
2	Open Isolation Solenoid or EBCM Malfunction	5E3-18
3	Open Dump Solenoid or EBCM Malfunction	5E3-20
4	Grounded Antilock Pressure Valve Reset Switch	5E3-22
5	Excessive Dump Valve Actuations During an Antilock Stop	5E3-24
6	Erratic Speed Signal	5E3-26
7	Shorted Isolation Solenoid or EBCM Malfunction	5E3-28
8	Shorted Dump Solenoid or EBCM Malfunction	5E3-30
9	Open or Grounded Speed Signal Circuit	5E3-32
10	Stop Lamp Switch Circuit	5E3-34
1, 11, 12	Invalid Diagnostic Trouble Codes	5E3-36
13, 14, 15	Electric Brake Control Module Malfunction	5E3-38

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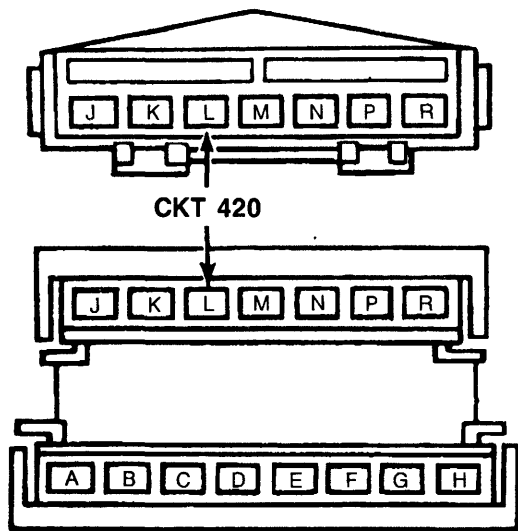
REAR WHEEL ANTILOCK BRAKE SYSTEM 5E3-9



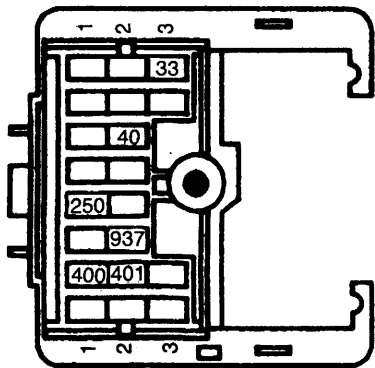
V3119

Figure 6—Wiring Diagram

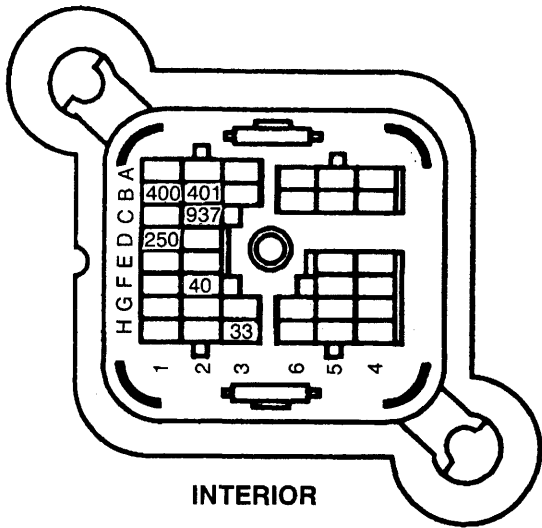
5E3-10 REAR WHEEL ANTILOCK BRAKE SYSTEM



ENGINE HARNESS CONNECTOR



EXTERIOR



INTERIOR

BULKHEAD CONNECTOR

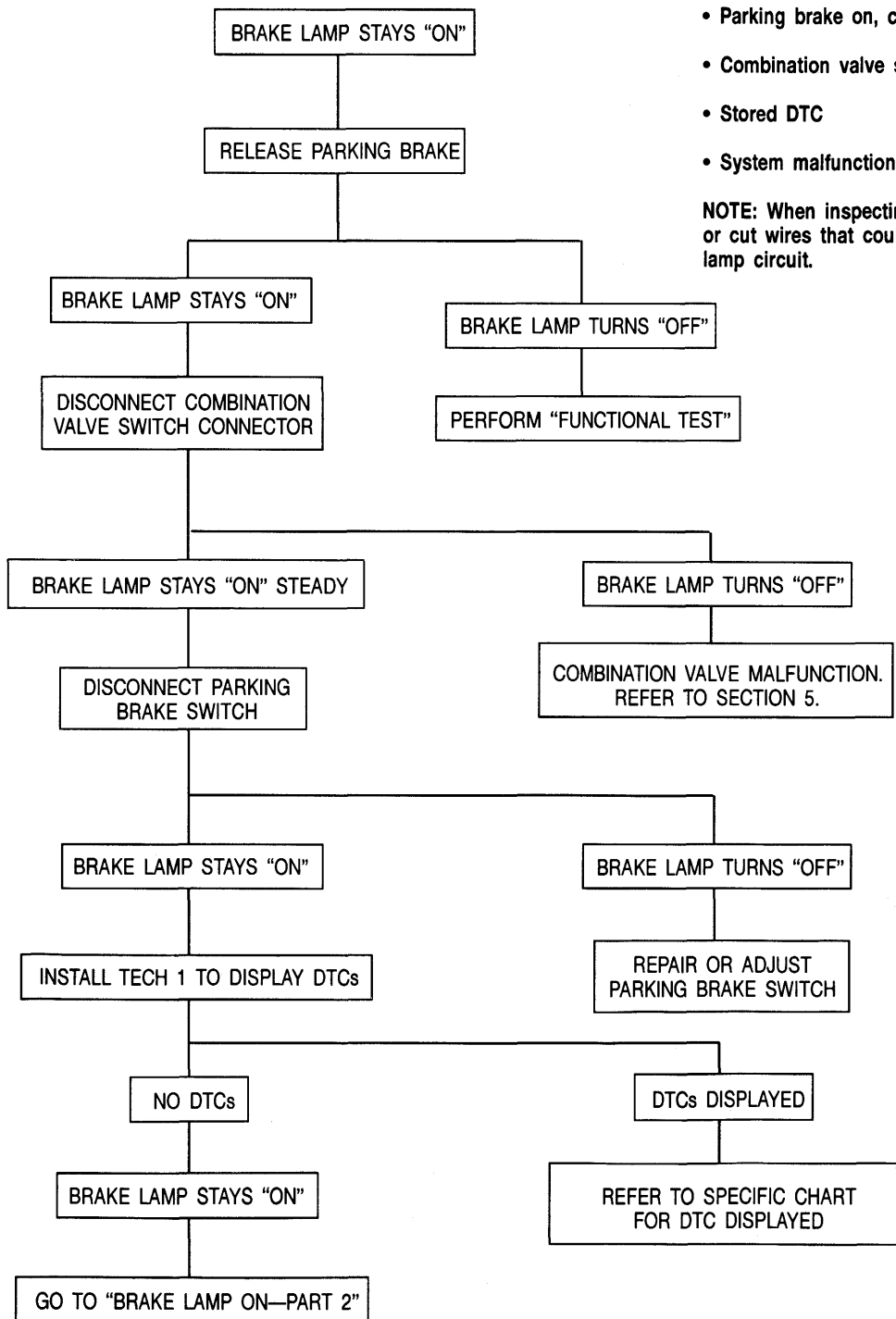
Figure 7—Connector Face Views

BRAKE LAMP ON—PART 1

This diagnostic chart checks for the following causes:

- Parking brake on, circuit, or switch problem
- Combination valve switch closed
- Stored DTC
- System malfunction

NOTE: When inspecting circuit, check for chafed or cut wires that could be grounding the brake lamp circuit.



5E3-12 REAR WHEEL ANTILOCK BRAKE SYSTEM

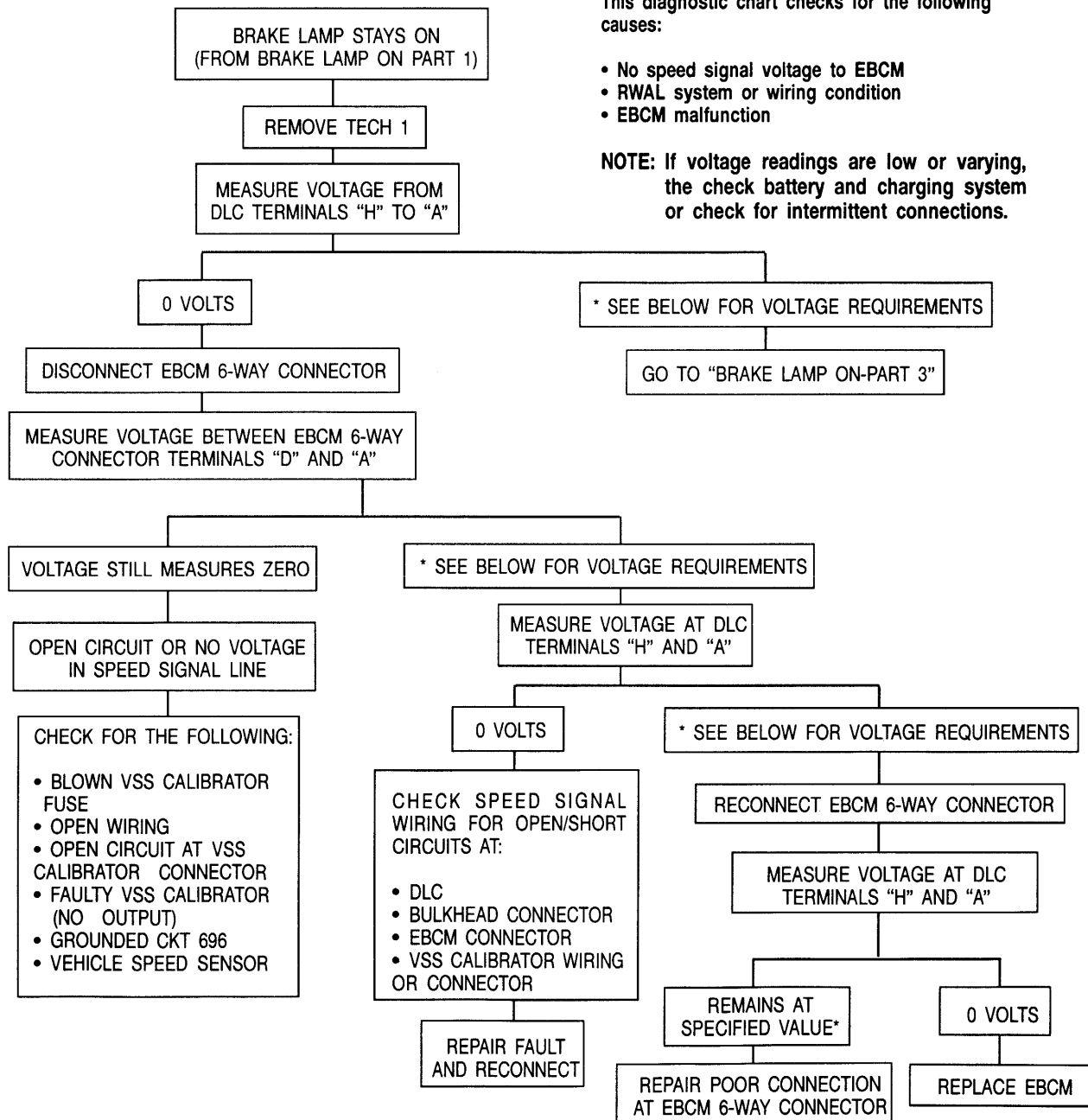
BRAKE LAMP ON—PART 2

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.

This diagnostic chart checks for the following causes:

- No speed signal voltage to EBCM
- RWAL system or wiring condition
- EBCM malfunction

NOTE: If voltage readings are low or varying, the check battery and charging system or check for intermittent connections.



* RWAL AND ZPRWAL EBCMS HAVE DIFFERENT VOLTAGE REQUIREMENTS.

—ZPRWAL (EBCM WITH GRAY CONNECTOR END — 30 SERIES HD) 6 TO 15 VOLTS

—RWAL (EBCM WITH BLACK CONNECTOR END — ALL OTHER MODELS) 8 TO 15 VOLTS

BRAKE LAMP ON—PART 3

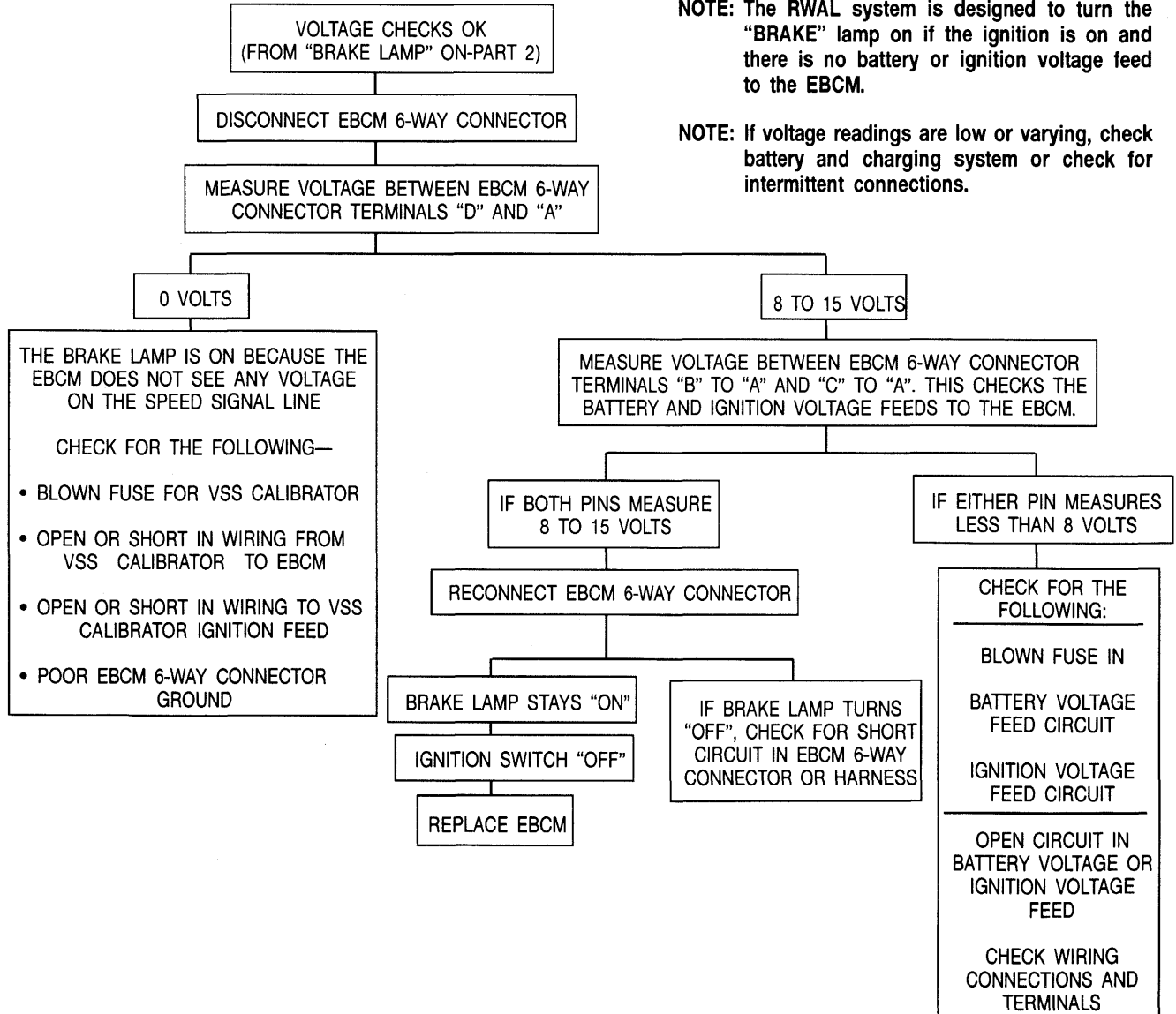
NOTICE WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.

This diagnostic chart checks for the following causes:

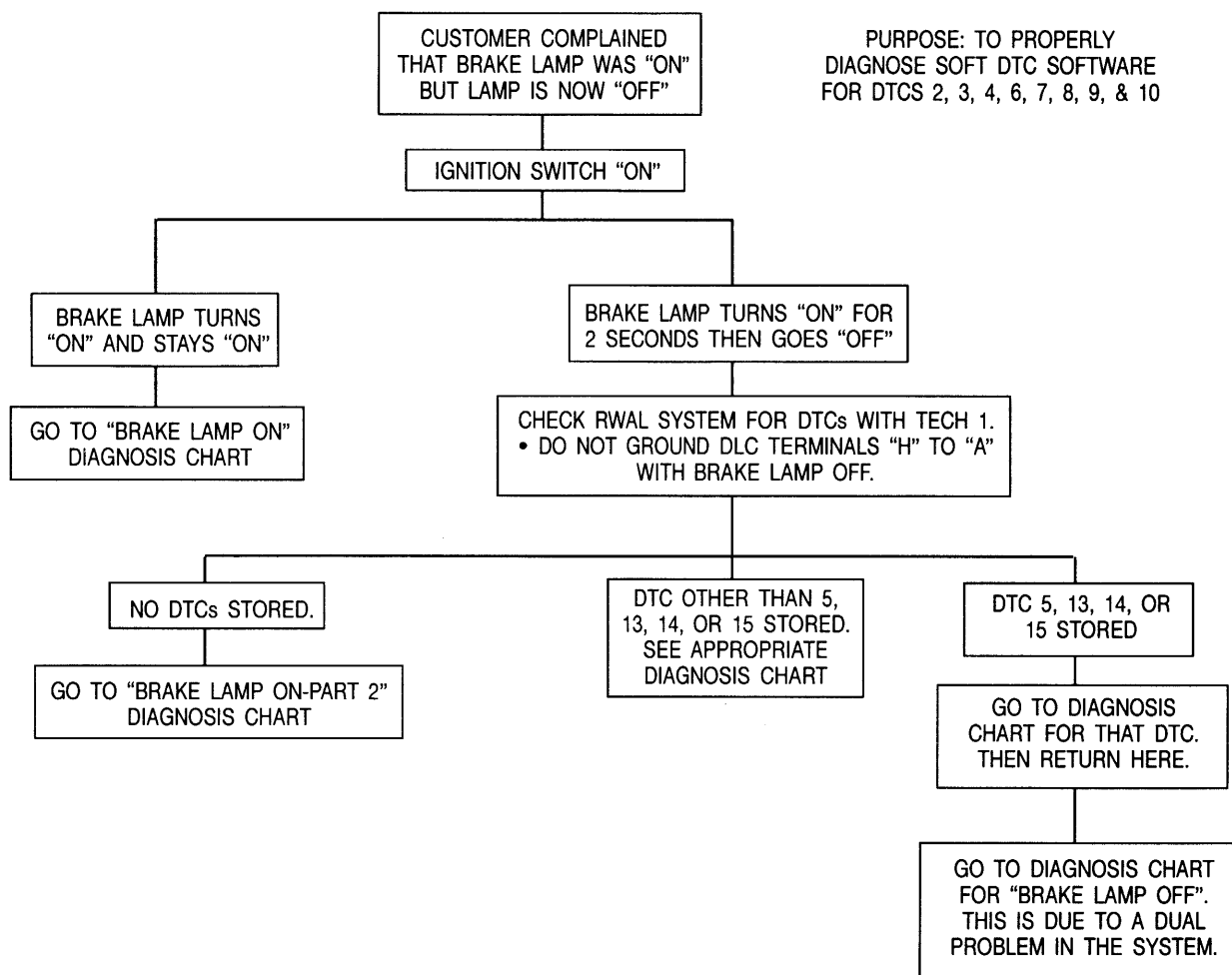
- No Power to VSS calibrator
- No battery voltage feed to EBCM
- No Ignition voltage feed to EBCM
- EBCM malfunction

NOTE: The RWAL system is designed to turn the "BRAKE" lamp on if the ignition is on and there is no battery or ignition voltage feed to the EBCM.

NOTE: If voltage readings are low or varying, check battery and charging system or check for intermittent connections.



INTERMITTENT BRAKE LAMP



- DO NOT ATTEMPT TO GROUND DLC TERMINALS "H" TO "A" WHEN THE BRAKE LAMP IS OFF. RESULT WILL BE A FALSE DTC 9 STORED.

- SOFT DTCS 2, 3, 4, 6, 7, 8, 9, & 10 HAVE BEEN INTRODUCED DUE TO INTERMITTENT CONNECTIONS. IF THE CONDITION GOES AWAY THE DTC WILL BE STORED TO AID IN DIAGNOSTICS. HOWEVER, THE BRAKE LAMP WILL BE TURNED OFF WITH THE NEXT TIME THE IGNITION SWITCH IS TURNED "OFF" AND THE BRAKE LAMP WILL BE TURNED OFF WITH DTC 10 WHEN THE EBCM SEES 12 VOLTS FROM THE BRAKE SWITCH.

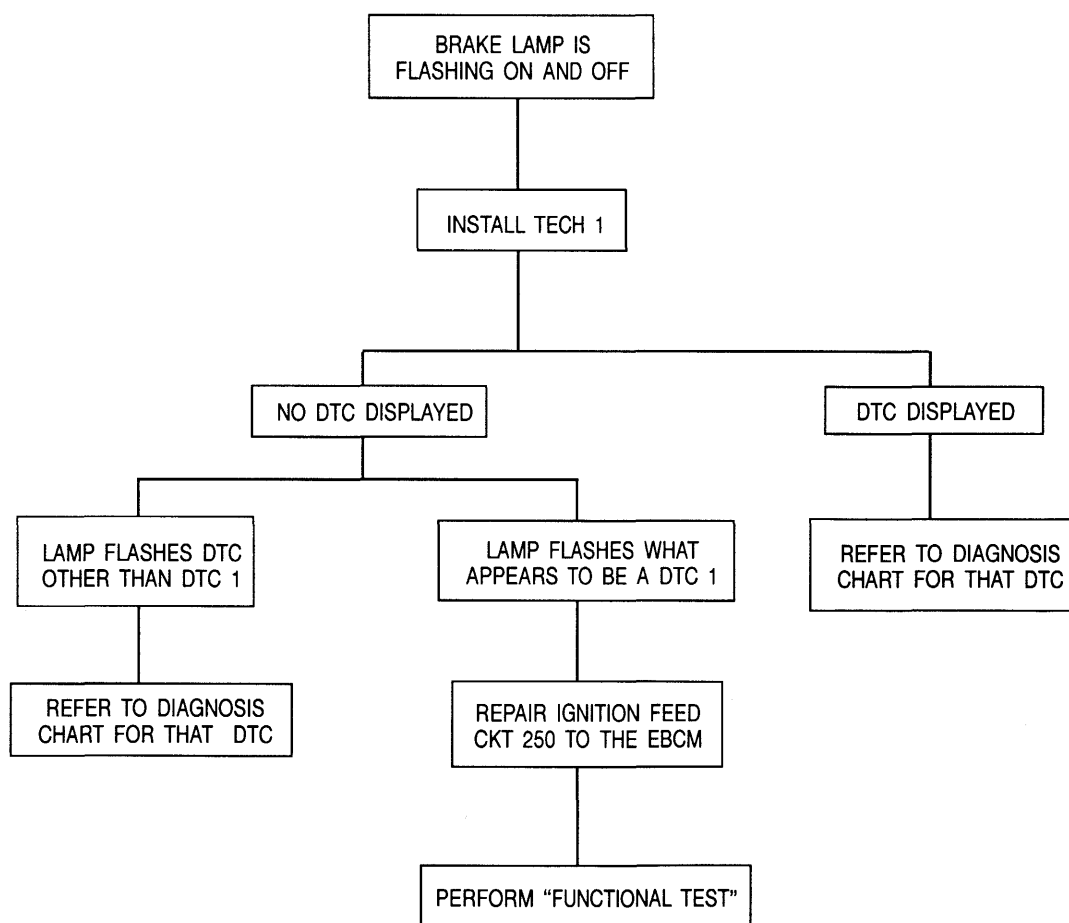
BRAKE LAMP FLASHING

THIS DIAGNOSTIC CHART CHECKS FOR THE FOLLOWING CAUSES:

- INTERMITTENT SPEED SIGNAL VOLTAGE TO THE EBCM
- SYSTEM MALFUNCTION (STORED DTC)

NOTE: IF VOLTAGE READINGS ARE TOO LOW OR VARYING, CHECK BATTERY AND CHARGING SYSTEM OR CHECK FOR INTERMITTENT CONNECTIONS.

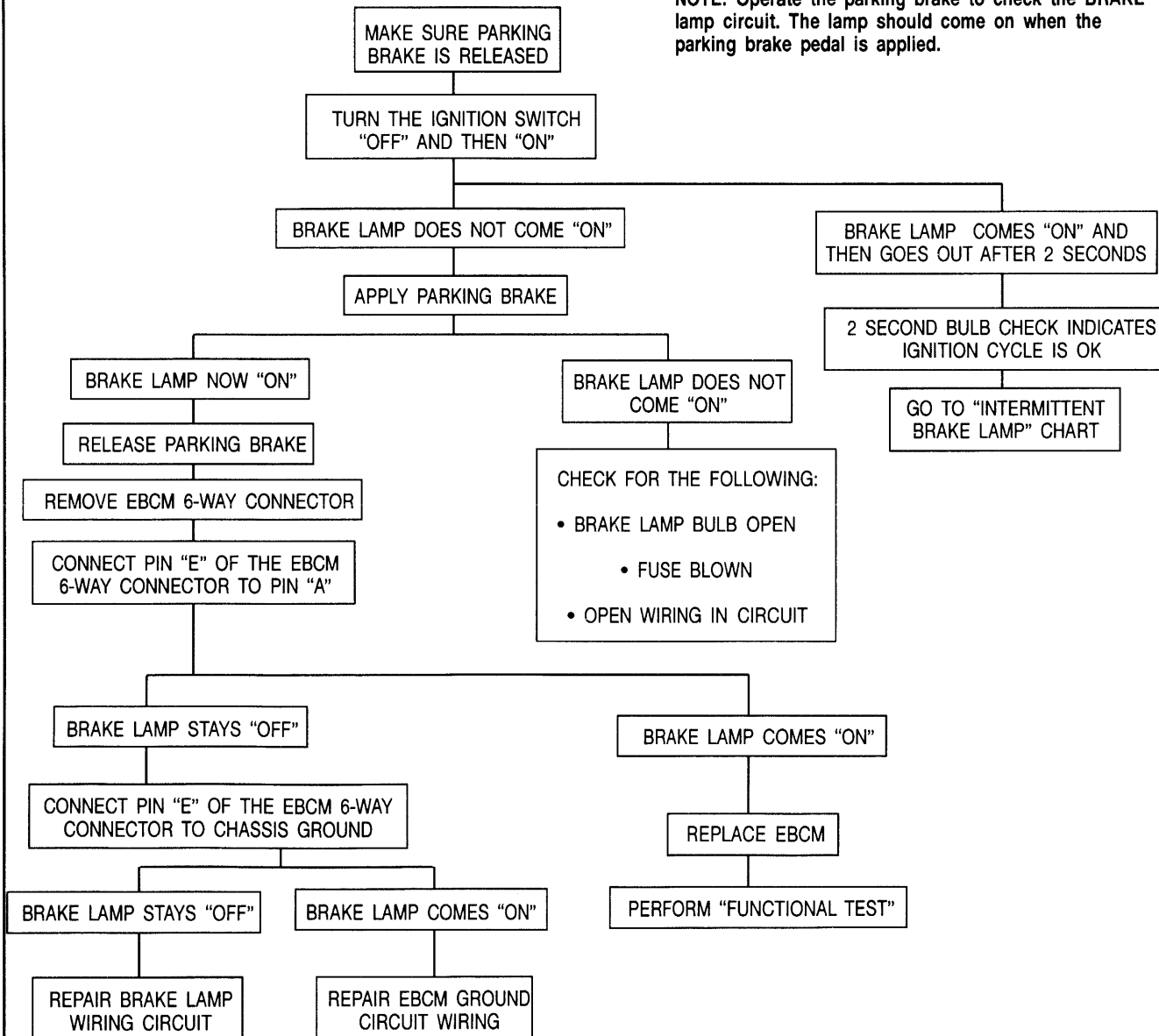
NOTE: DTC MAY BE FLASHED OUT UNDER UNUSUAL CIRCUMSTANCES.



BRAKE LAMP OFF

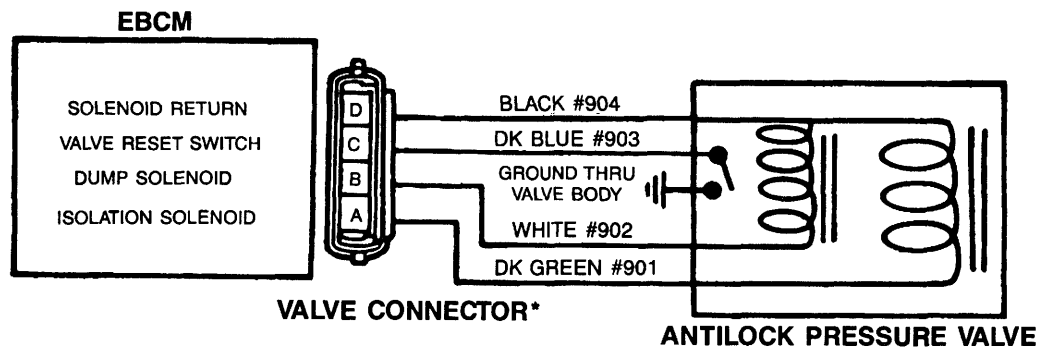
The EBCM should perform a BRAKE lamp check when the ignition switch is turned "ON". The EBCM turns the BRAKE lamp on for 2 seconds then turns it off. The Brake lamp going out after 2 seconds indicates that the EBCM ignition cycle checked ok.

NOTE: Operate the parking brake to check the BRAKE lamp circuit. The lamp should come on when the parking brake pedal is applied.



BLANK

5E3-18 REAR WHEEL ANTILOCK BRAKE SYSTEM



* NOTICE: DO NOT PIERCE CONNECTOR, OR WIRES.
THIS WILL BREAK THE SEAL AND COULD LEAD
TO A POOR CONNECTION

V1282

DIAGNOSTIC TROUBLE CODE 2 OPEN ISOLATION SOLENOID OR EBCM MALFUNCTION

CIRCUIT DESCRIPTION:

A DTC 2 relates to an open in the APV isolation valve circuit. The EBCM uses the isolation valve to maintain and increase pressure in the brake pipes during an antilock stop. An open in the solenoid winding or circuit prevents the EBCM from controlling the rear wheels when a speed decrease is detected.

TEST DESCRIPTION:

- Check for continuity through the isolation solenoid winding.
- Check for a consistent DTC being set after clearing the memory.

- Check for corrosion or poor contact in the solenoid electrical terminals.
- Check the resistance of the solenoid after the terminal repair to see if it corrected the open condition.

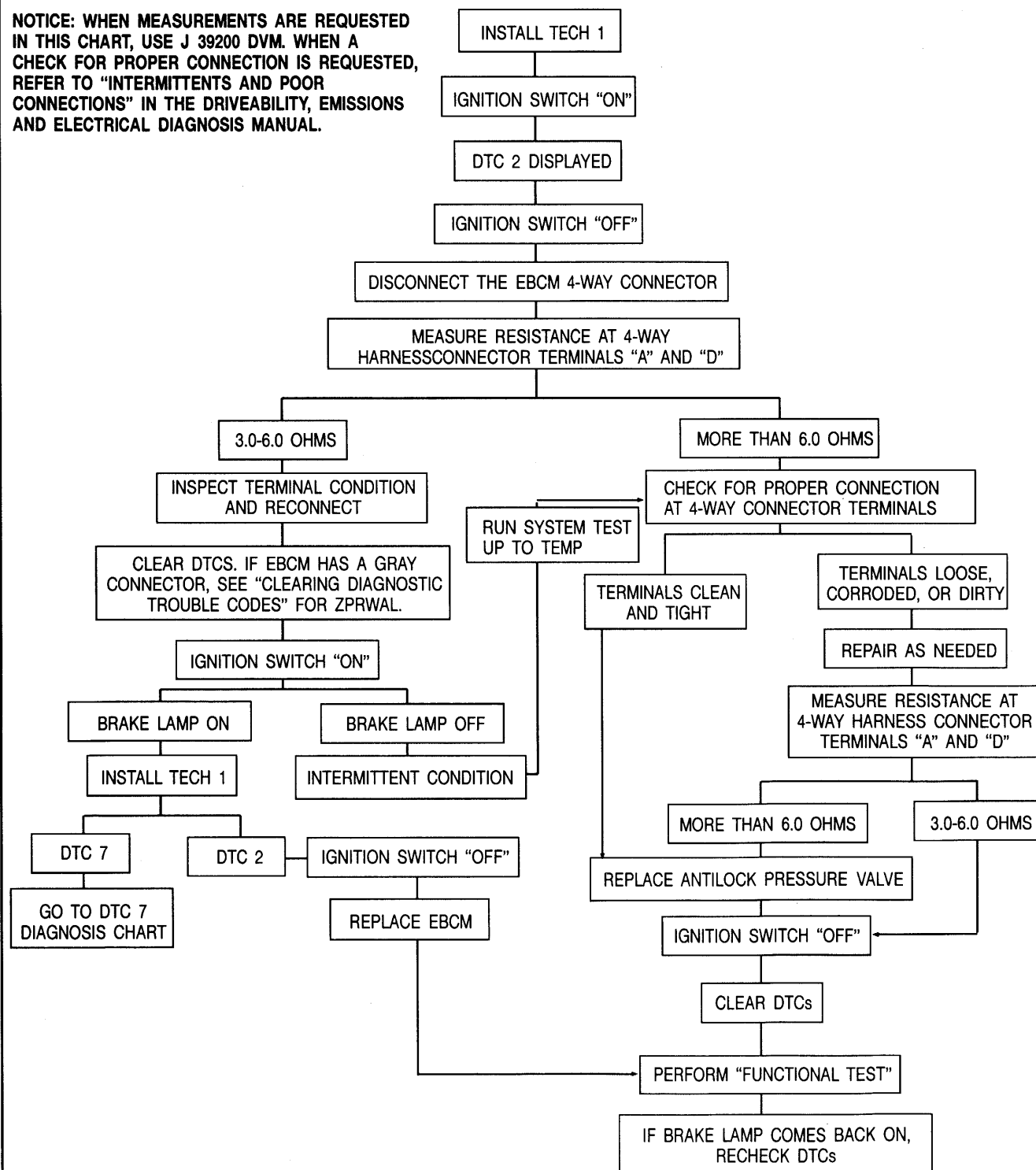
DIAGNOSTIC AIDS:

A DTC 2 will set if the 4-way connector is disconnected and the ignition switch is turned on or the 6-way connector is plugged in before the 4-way connector with the ignition switch on.

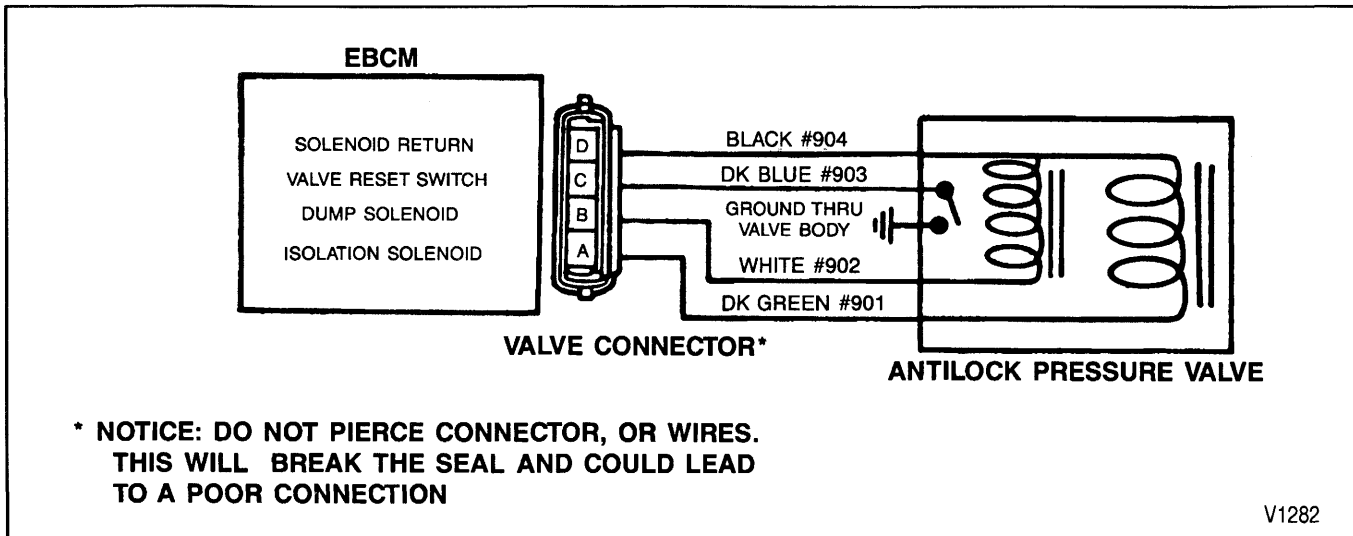
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 2 OPEN ISOLATION SOLENOID OR EBCM MALFUNCTION

NOTICE: WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E3-20 REAR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 3 OPEN DUMP SOLENOID OR EBCM MALFUNCTION

CIRCUIT DESCRIPTION:

A DTC 3 relates to an open in the APV dump valve circuit. The EBCM uses the dump valve to reduce fluid pressure in the brake lines when it senses the wheel is locking up. The fluid pressure is routed to an accumulator. An open dump solenoid prevents the EBCM from reducing the pressure and the wheel will continue to lock up.

TEST DESCRIPTION:

- Check for continuity through the dump solenoid winding.
- Check for a consistent DTC being set after clearing the memory.

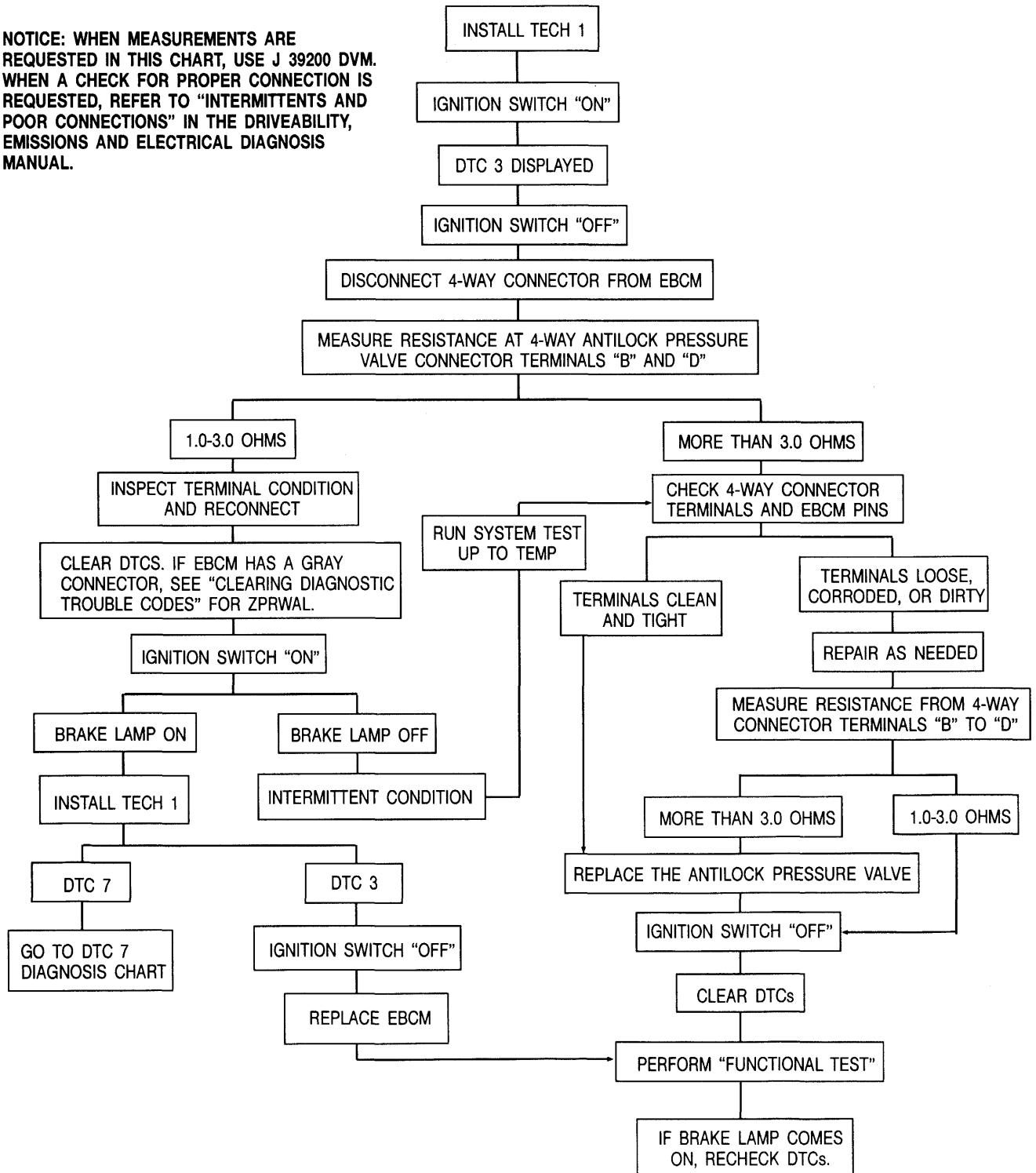
- Check for corrosion or poor contact in the solenoid electrical terminals.
- Check the resistance of the solenoid after the terminal repair to see if it corrected the open condition.

DIAGNOSTIC AIDS:

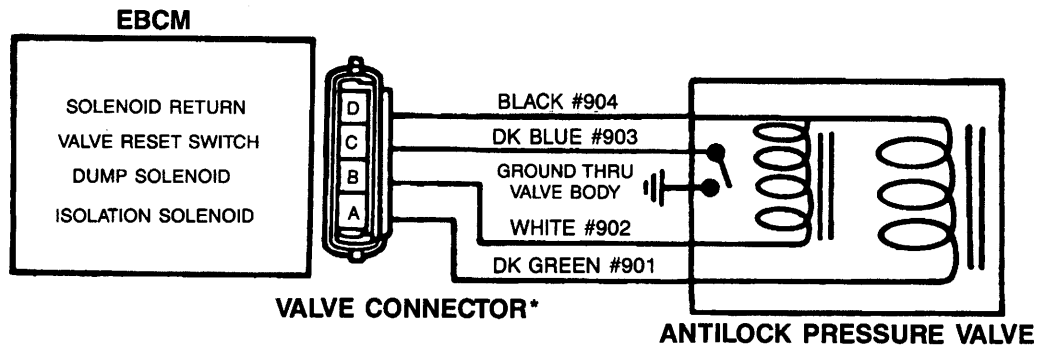
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 3 OPEN DUMP SOLENOID OR EBCM MALFUNCTION

NOTICE: WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E3-22 REAR WHEEL ANTILOCK BRAKE SYSTEM



* NOTICE: DO NOT PIERCE CONNECTOR, OR WIRES.
THIS WILL BREAK THE SEAL AND COULD LEAD
TO A POOR CONNECTION

V1282

DIAGNOSTIC TROUBLE CODE 4 GROUNDED ANTILOCK PRESSURE VALVE RESET SWITCH

CIRCUIT DESCRIPTION:

A DTC 4 relates to a grounded condition in the APV reset switch. The reset switch grounds pin C of the EBCM 4-way connector when there is a great enough difference between inlet and outlet pressure in the antilock pressure valve. An example of this is during a pressure decrease operation. With a grounded reset switch, the EBCM has no way of determining if pressure changes are occurring in the antilock pressure valve. The reset switch is constantly signaling that pressure decrease has occurred.

TEST DESCRIPTION:

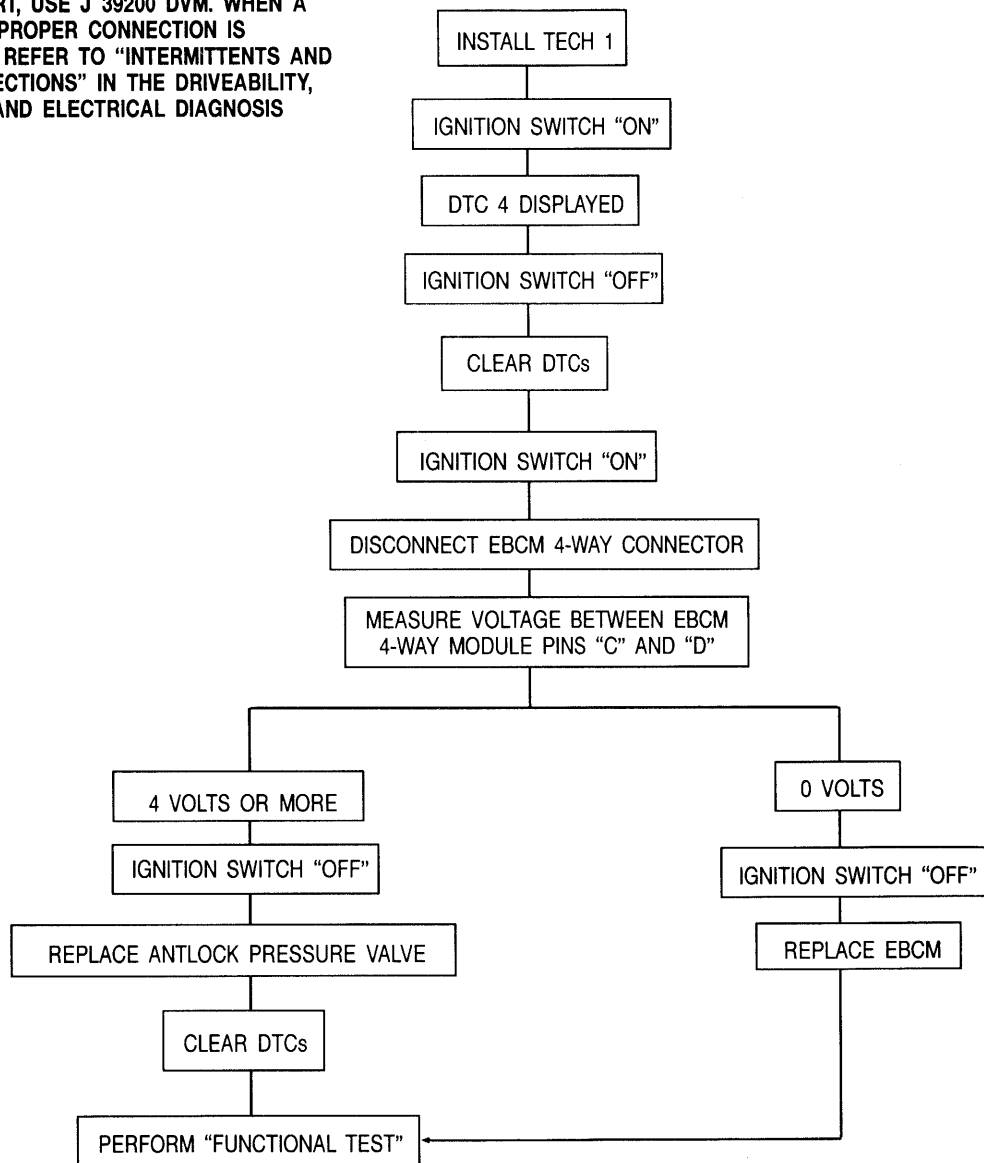
- Clear the DTCs in the EBCM memory.
- Check the voltage signal to the reset switch to see if the EBCM is operational.

DIAGNOSTIC AIDS:

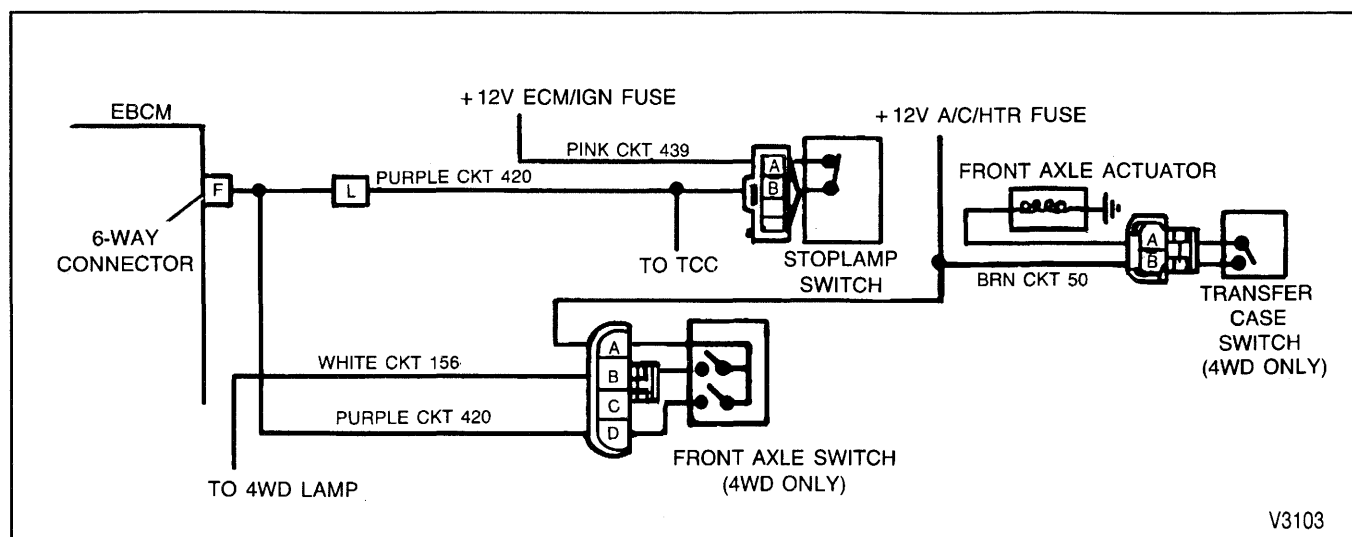
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 4 GROUNDED ANTILOCK PRESSURE VALVE RESET SWITCH

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS, AND ELECTRICAL DIAGNOSIS MANUAL.



5E3-24 REAR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 5 EXCESSIVE DUMP VALVE ACTUATIONS DURING AN ANTILOCK STOP

CIRCUIT DESCRIPTION:

A DTC 5 relates to a condition where the EBCM is having to cycle the dump valve too many times during an antilock stop. A mechanical locking condition in the rear brakes or powertrain can cause this DTC to set. This DTC can also be set if the RWAL system is working with the vehicle in 4WD.

TEST DESCRIPTION:

- Check if the rear brakes or powertrain are causing the malfunction.
- This test only applies to vehicles with 4WD. Check if the front axle switch can turn on the 4WD indicator on the instrument cluster.

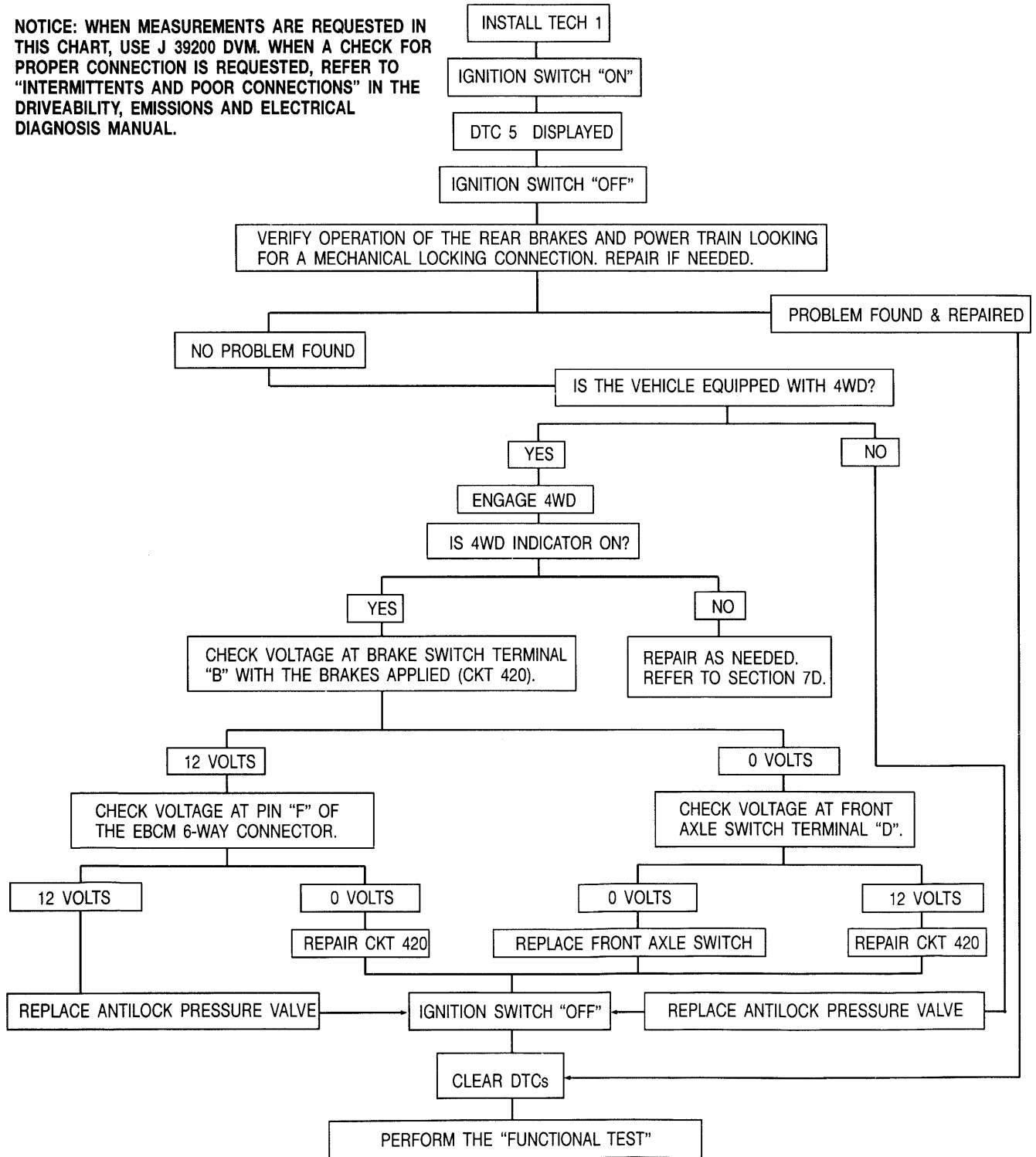
- Check if the voltage is present in CKT 420.
- Check the operation of the front axle switch.
- Check for the 4WD voltage signal at the EBCM.

DIAGNOSTIC AIDS:

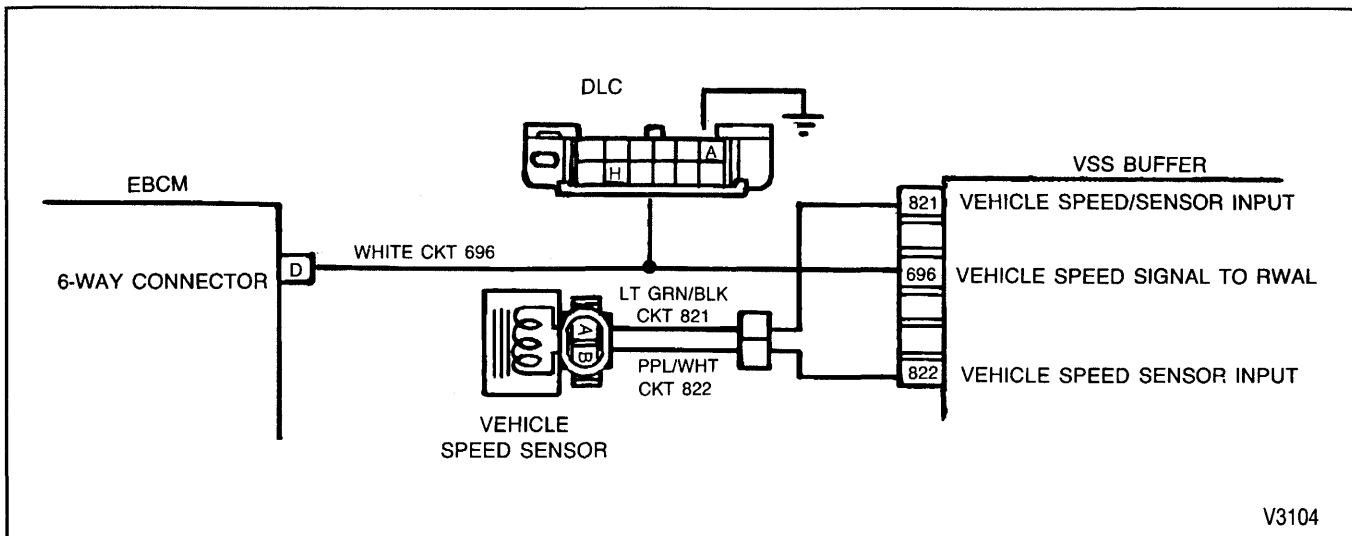
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 5 EXCESSIVE DUMP VALVE ACTUATIONS DURING AN ANTILOCK STOP

NOTICE: WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E3-26 REAR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 6 ERRATIC SPEED SIGNAL

CIRCUIT DESCRIPTION:

A DTC 6 is a soft fault. If the speed signal line to the EBCM drops out and returns often, this DTC is set in memory. The "BRAKE" lamp will illuminate when the DTC is set and turn off with the next ignition cycle. **Do not replace the EBCM to repair this DTC.** An erratic speed signal relates to a malfunction in either the VSS, VSS buffer, or speed signal circuit. It can be set by a poor connection in the speed signal line.

TEST DESCRIPTION:

- Check if all systems are receiving an erratic speed signal or if it is just the RWAL system.
- Check the VSS output using the Tech 1.
- Check the resistance of the VSS.
- Check for an open condition in CKT 822.
- Check for excessive resistance in CKT 696.

DIAGNOSTIC AIDS:



Important

- Do not replace the EBCM for this DTC. An EBCM malfunction will not cause this DTC to set.

If the voltage readings are low or varying, the battery, charging system, or intermittent connections could be the cause. Check these areas before replacing any components.

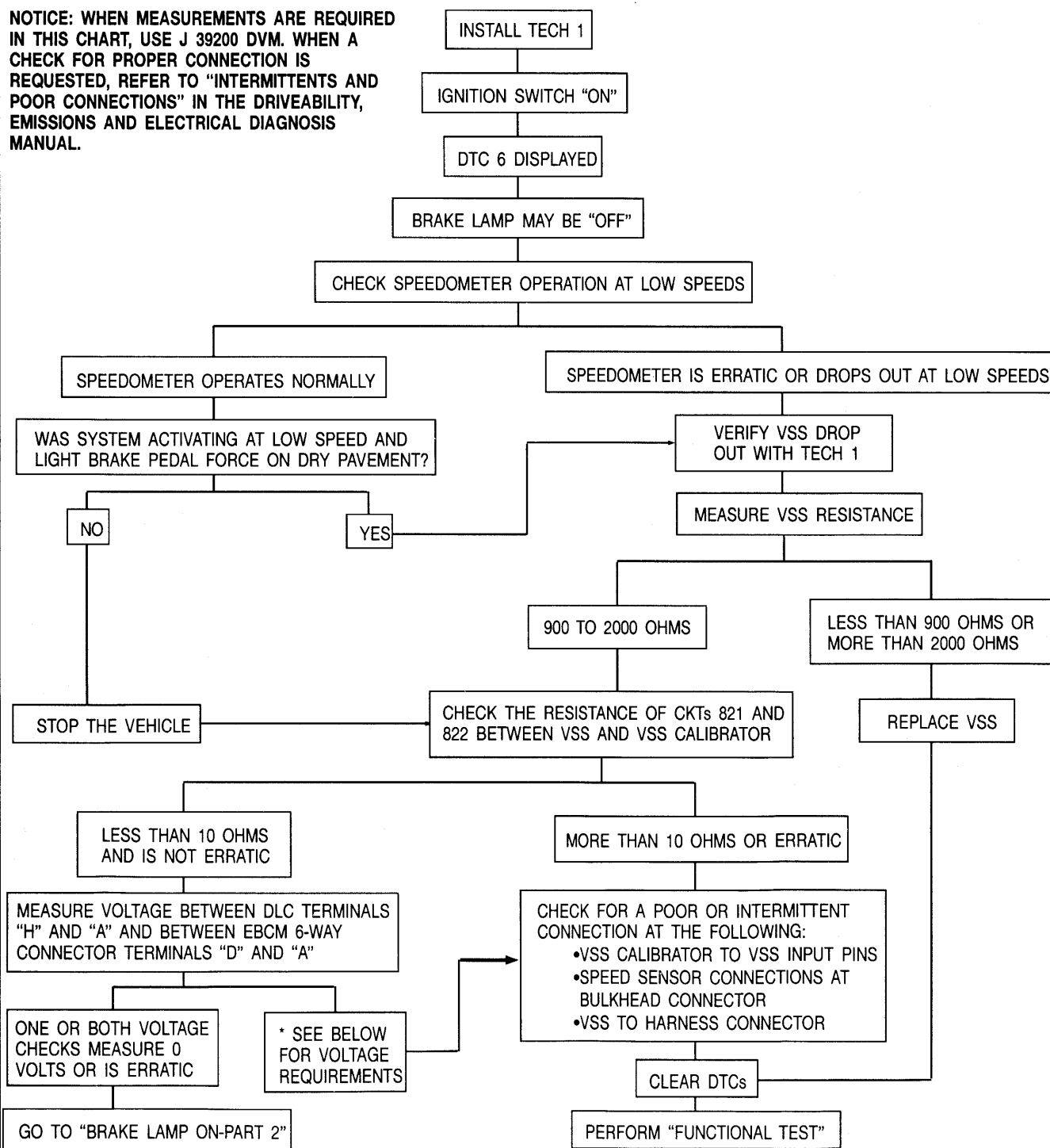
This DTC is a soft fault and can be set with a 2WD transmission on ice wheel spins.

If the "BRAKE" lamp is not on, do not ground DLC terminals H to A. Doing so will set a false DTC 9.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 6 ERRATIC SPEED SIGNAL

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.

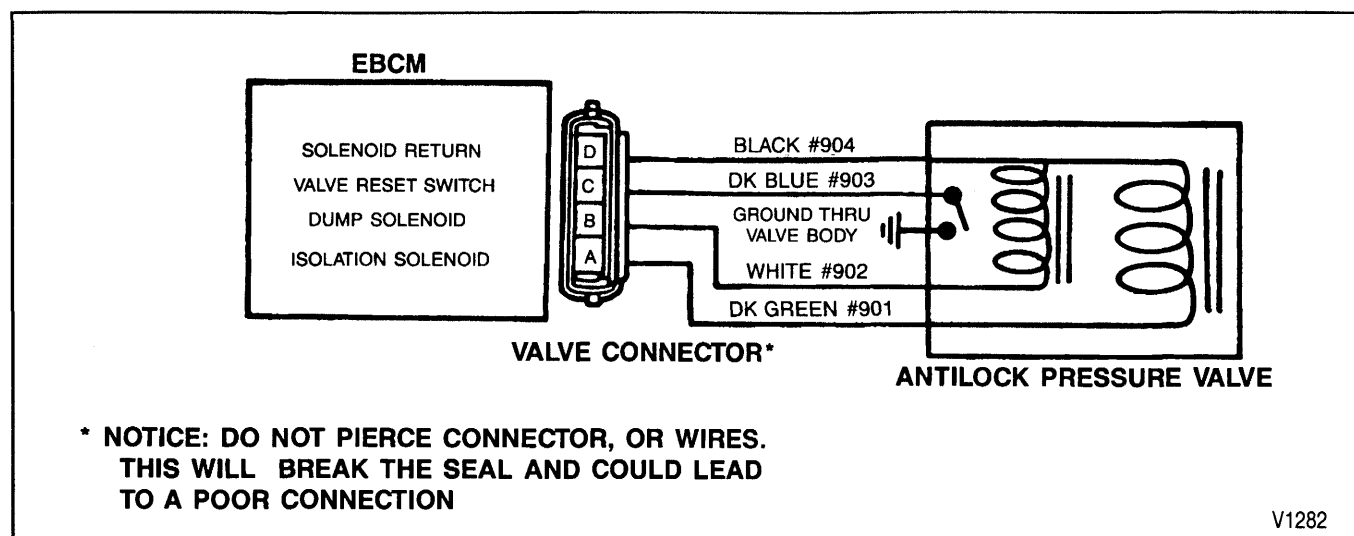


*RWAL AND ZPRWAL EBCMS HAVE DIFFERENT VOLTAGE REQUIREMENTS.

—ZPRWAL (EBCM WITH GRAY CONNECTOR END — 30 SERIES HD) 6 TO 15 VOLTS

—RWAL (EBCM WITH BLACK CONNECTOR END — ALL OTHER MODELS) 8 TO 15 VOLTS

5E3-28 REAR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 7 SHORTED ISOLATION SOLENOID OR EBCM MALFUNCTION

CIRCUIT DESCRIPTION:

A DTC 7 sets when the EBCM detects a short in the isolation valve solenoid or circuit. With the isolation valve shorted the EBCM cannot provide any of the pressure control functions. The short can be located in the APV, EBCM, or circuit between them.

TEST DESCRIPTION:

- Check the EBCM's internal circuitry for the isolation valve solenoid.
- Check the resistance of the isolation solenoid winding.

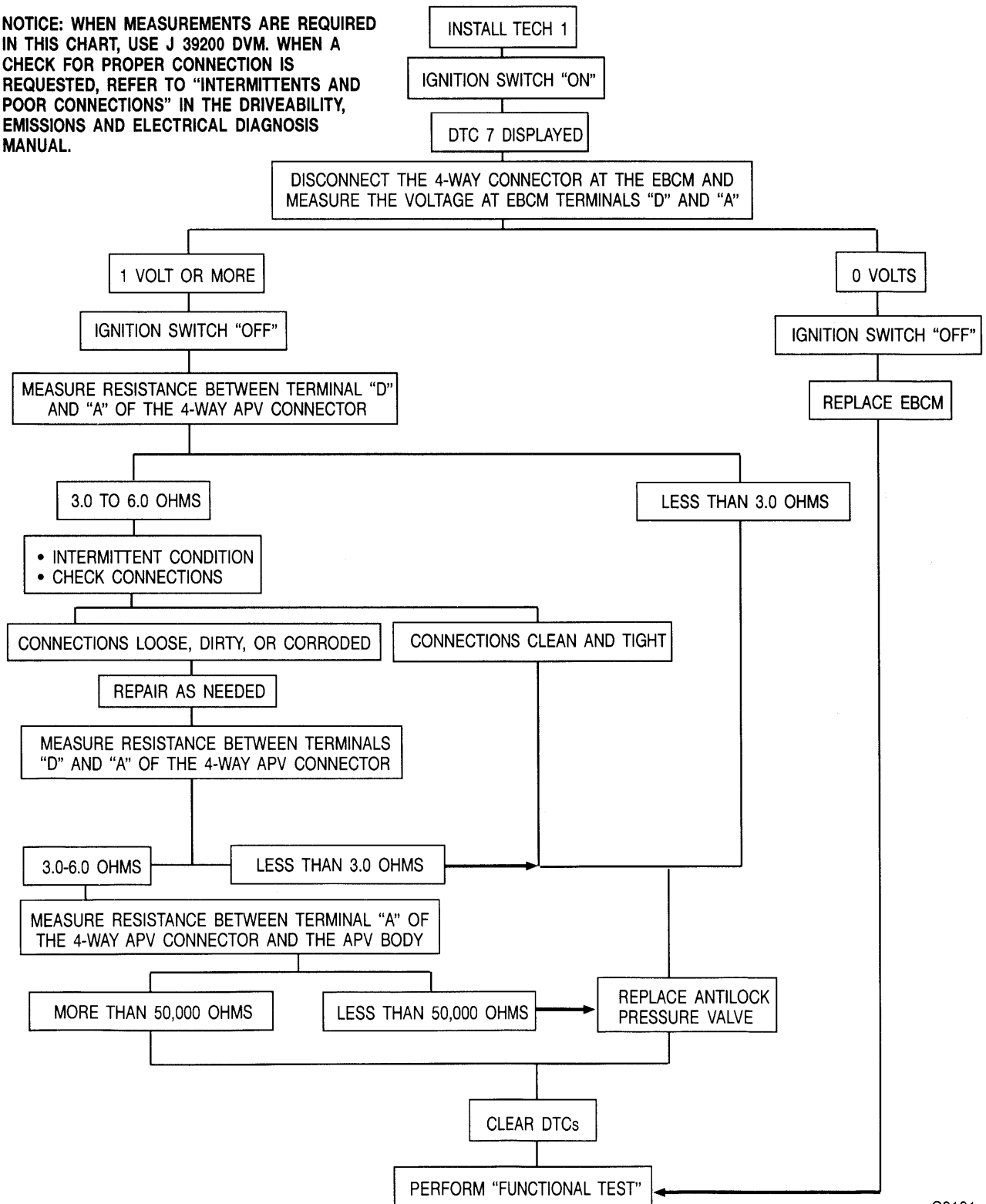
- Check if the connector repair corrected the condition.
- Check for a short to ground in the APV.

DIAGNOSTIC AIDS:

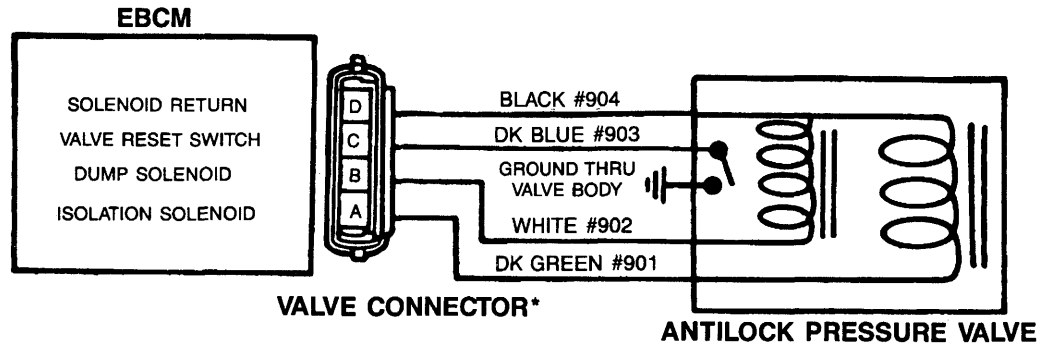
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 7 SHORTED ISOLATION SOLENOID OR EBCM MALFUNCTION

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E3-30 REAR WHEEL ANTILOCK BRAKE SYSTEM



* NOTICE: DO NOT PIERCE CONNECTOR, OR WIRES.
THIS WILL BREAK THE SEAL AND COULD LEAD
TO A POOR CONNECTION

V1282

DIAGNOSTIC TROUBLE CODE 8 SHORTED DUMP SOLENOID OR EBCM MALFUNCTION

CIRCUIT DESCRIPTION:

A DTC 8 sets when the EBCM detects a short in the dump valve solenoid or circuit. Without the use of the dump valve, the EBCM cannot allow a pressure decrease or relieve the brake fluid in the accumulator. This DTC can be caused by a short in the APV, EBCM, or circuit between them.

TEST DESCRIPTION:

- Check the resistance of the dump valve solenoid winding.
- Check for a short to ground in the antilock pressure valve.

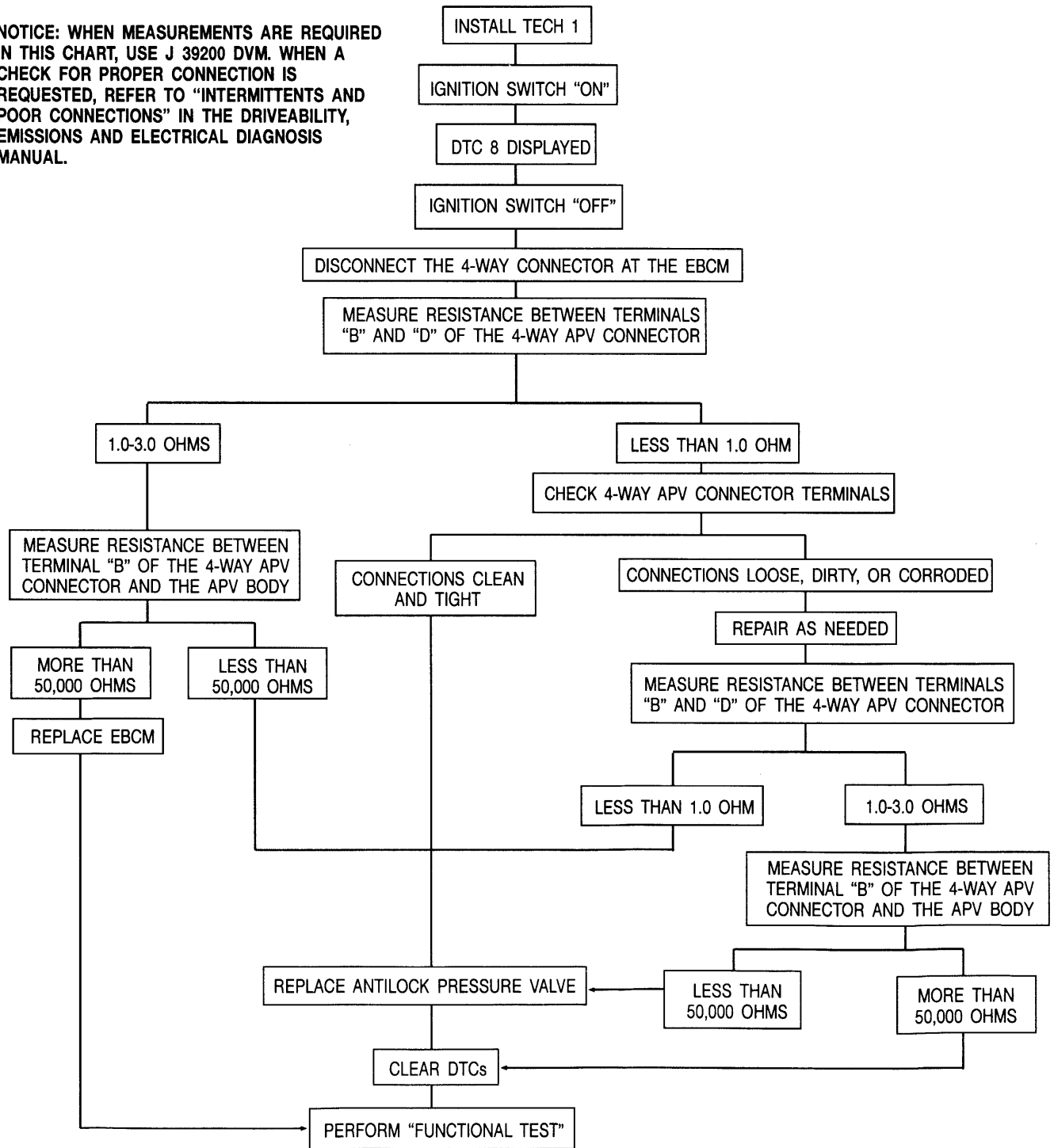
- Check if the connector repair corrected the condition.
- Check for a short to ground in the antilock pressure valve.

DIAGNOSTIC AIDS:

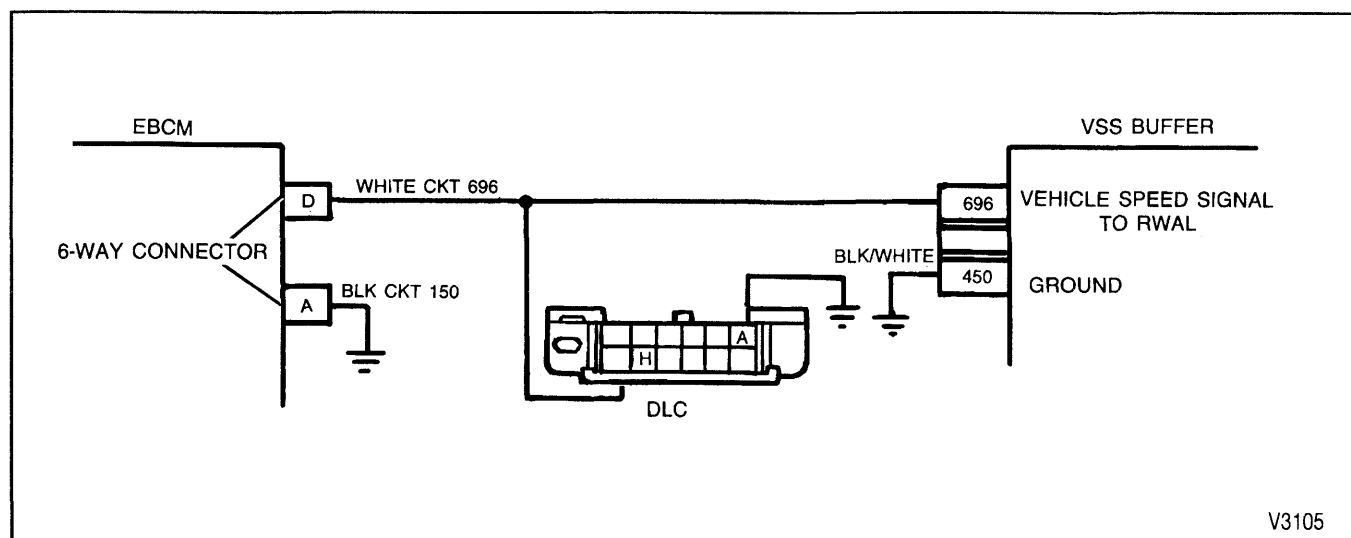
Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 8 SHORTED DUMP SOLENOID OR EBCM MALFUNCTION

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



5E3-32 REAR WHEEL ANTILOCK BRAKE SYSTEM



DIAGNOSTIC TROUBLE CODE 9 OPEN OR GROUNDED SPEED SIGNAL CIRCUIT

CIRCUIT DESCRIPTION:

A DTC 9 is a soft fault. If the speed signal line to the EBCM drops out and returns, this DTC is set in memory. The BRAKE lamp will illuminate when the DTC is set and turn off with the next ignition cycle. An open or grounded speed signal relates to a malfunction in the VSS buffer or speed signal circuit (CKT 696). It can be set by a poor connection in the speed signal line.

TEST DESCRIPTION:

- Check the voltage in CKT 696.
- Check for an open in CKT 696, a blown VSS buffer fuse, or a malfunctioning VSS buffer.
- Check the voltage applied at the EBCM connector.
- Check for added resistance or an open in CKT 696.

DIAGNOSTIC AIDS:



Important

- Do not replace the EBCM for this DTC. An EBCM malfunction will not cause this DTC to set.

If the "BRAKE" lamp is not on, do not ground DLC terminals H to A. Doing so will set a false DTC 9.

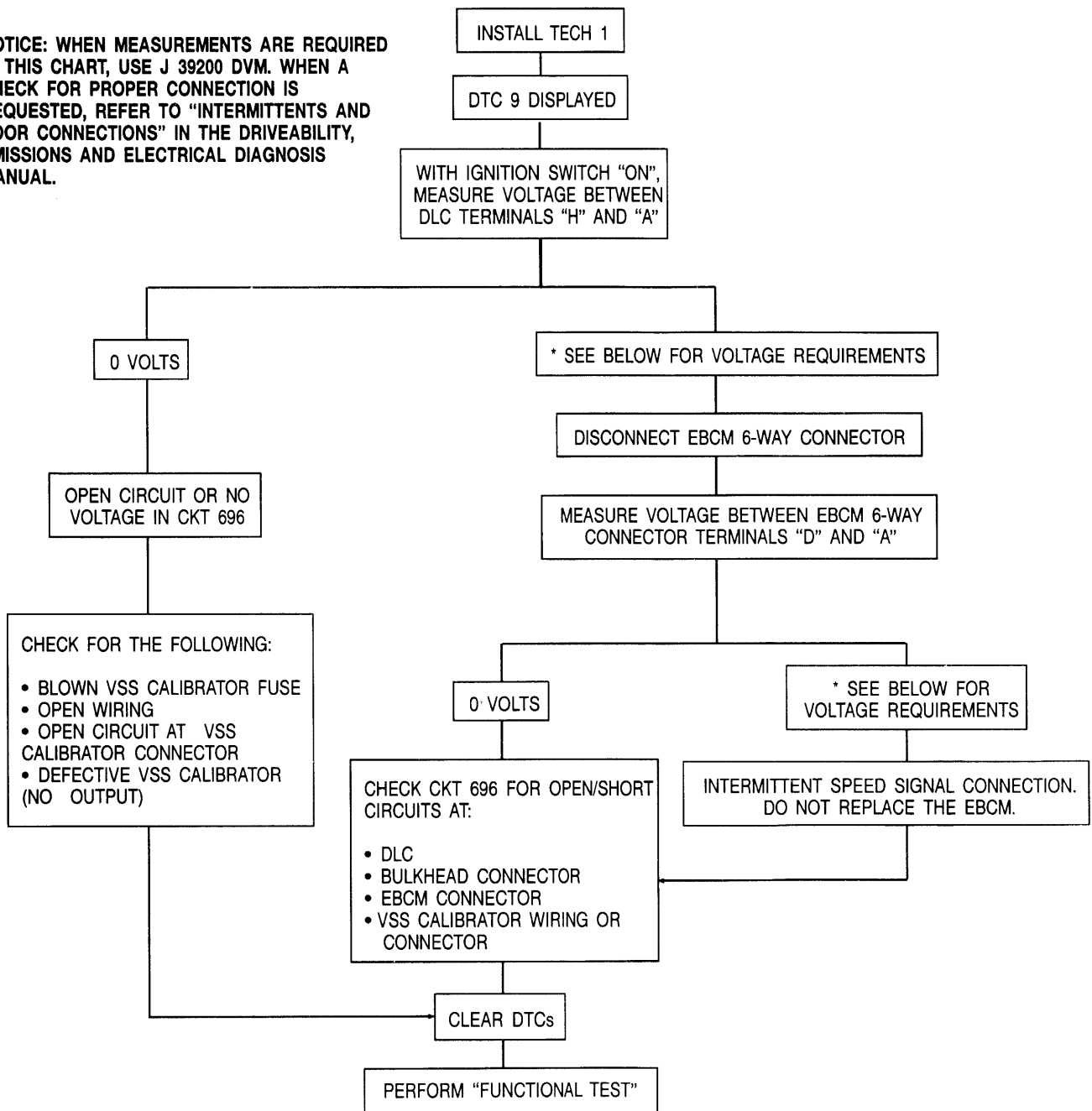
This is a soft fault that keeps the "BRAKE" lamp illuminated until the next ignition cycle.

If voltage readings are low or varying, the battery, charging system, or intermittent connections could be the cause. Check these areas before replacing any components.

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 9 OPEN OR GROUNDED SPEED SIGNAL CIRCUIT

NOTICE: WHEN MEASUREMENTS ARE REQUIRED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



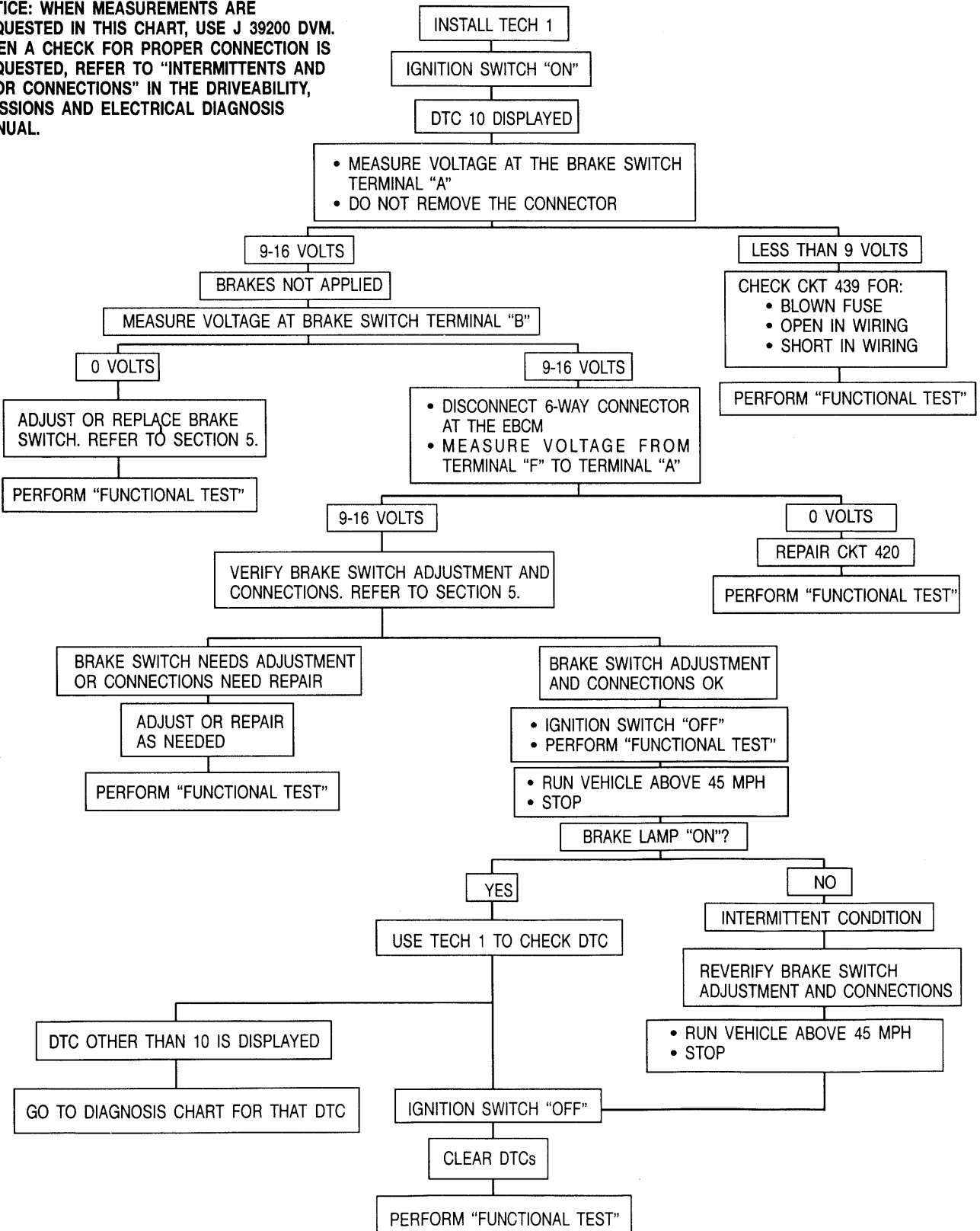
* RWAL AND ZPRWAL EBCMS HAVE DIFFERENT VOLTAGE REQUIREMENTS.
 —ZPRWAL (EBCM WITH GRAY CONNECTOR END — 30 SERIES HD) 6 TO 15 VOLTS
 —RWAL (EBCM WITH BLACK CONNECTOR END — ALL OTHER MODELS) 8 TO 15 VOLTS

[illegible]

Do not pierce the electrical connectors, wires, seals, or insulation during testing. Doing so will break the seal and lead to corrosion and failure of the wiring and terminals.

DTC 10-BRAKE SWITCH CIRCUIT

NOTICE: WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART, USE J 39200 DVM. WHEN A CHECK FOR PROPER CONNECTION IS REQUESTED, REFER TO "INTERMITTENTS AND POOR CONNECTIONS" IN THE DRIVEABILITY, EMISSIONS AND ELECTRICAL DIAGNOSIS MANUAL.



C0032

DIAGNOSTIC TROUBLE CODES 1, 11, AND 12 INVALID DIAGNOSTIC TROUBLE CODES

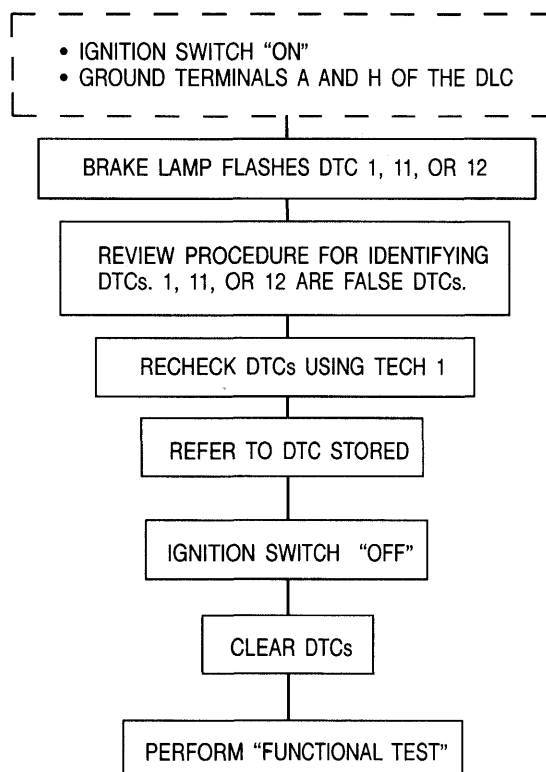
CIRCUIT DESCRIPTION:

DTCs 1, 11, and 12 do not exist. They are the result of misreading the "BRAKE" lamp flashes. **The Tech 1 scan tool will not display these DTCs.** If these DTCs are encountered, review the procedure for manually reading DTCs.

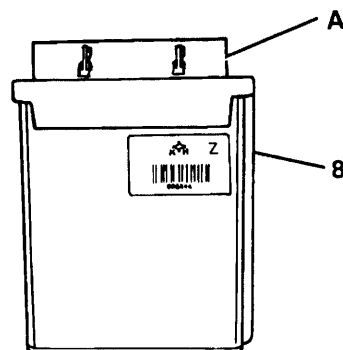
TEST DESCRIPTION

1. Check DTCs by manually grounding terminals A and H of the DLC.
2. Verify the correct procedure was used.
3. Check DTCs using the Tech 1.

**DTCS 1, 11, AND 12
INVALID DIAGNOSTIC TROUBLE CODES**



5E3-38 REAR WHEEL ANTILOCK BRAKE SYSTEM



- A. CONNECTOR
(ZPRWAL GRAY OR RWAL BLACK)
- 8. EBCM

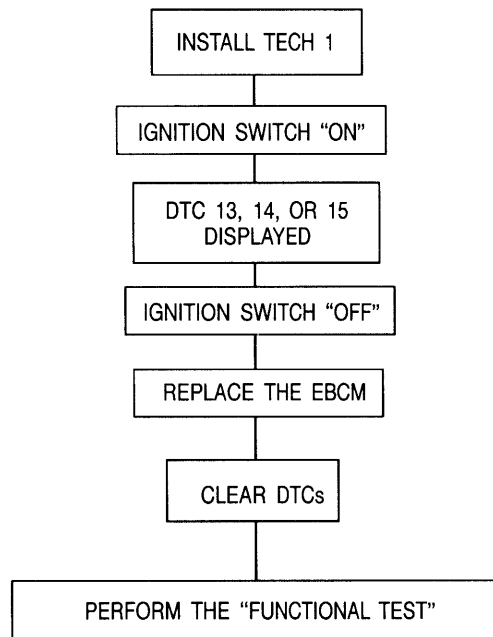
V3557

DIAGNOSTIC TROUBLE CODES 13, 14, AND 15 EBCM MALFUNCTION

CIRCUIT DESCRIPTION:

These DTCs relate to internal malfunctions in the EBCM. If the Tech 1 displays any of these DTCs, replace the EBCM. There are no tests to perform due to these DTCs being internal to the EBCM.

**DTC 13, 14, OR 15
EBCM MALFUNCTION**



ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

The RWAL and ZPRWAL systems are basically maintenance free. When doing work on these systems, the following must be observed:

- Before doing welding work on the vehicle with an electric welding unit, turn the ignition switch "OFF" and disconnect the EBCM connectors.
- Do not use a fast charger for starting the engine.
- Disconnect the negative battery cable when fast charging. Refer to SECTION 0A.
- Never disconnect the the battery from the vehicle electrical system with the engine running.
- Make sure all wiring harness connectors are securely connected.
- Always note the routing, position, mounting, and location of all components, wiring, connectors, clips, brackets, brake pipes, etc., when servicing the RWAL or ZPRWAL systems. Speed sensor wiring, routing, and retention is especially important to help prevent false signals due to electrical noise picked up by the wiring. Proper system operation can only be achieved if the system is restored to its original equipment condition.

The above mentioned items do not cover every possibility, but must be followed when working on RWAL or ZPRWAL. When doing service work, become familiar with RWAL, ZPRWAL, and how they may be interrelated with other components on the vehicle.

CHECKING AND ADDING FLUID

For information on checking and adding fluid to the brake hydraulic system, refer to SECTION 5A.

BLEEDING SYSTEM

NOTICE: The ignition switch must be in the "OFF" position or false DTCs could be set to memory.

Tools Required:

J 39177 Combination Valve Pressure Bleeding Tool
7000001 Mass Storage Cartridge
TK 00000 Tech-1 Scan Tool
TK 02650 RWAL/4WAL Cartridge Kit or
7000001 Mass Storage Cartridge

1. Install J 39177 on the combination valve.
2. Check the master cylinder reservoir fluid level and fill if needed.
3. Bleed wheel cylinders and calipers as described in SECTION 5.
4. Turn ignition switch "ON" and do three function tests with the Tech-1 scan tool.
5. Re-bleed the rear brakes. Refer to SECTION 5.
6. Evaluate brake pedal feel.
7. Repeat the bleed procedure if needed.

ELECTRIC BRAKE CONTROL MODULE

The electric brake control module (EBCM) is not serviceable. It should be replaced when the DTC charts show that it is the cause of a malfunction.

NOTICE: Be sure to use the correct EBCM for the system being serviced. The 3500 HD uses the ZPRWAL EBCM with the gray electrical connector. All other models use the RWAL EBCM with the black electrical connector. Failure to use the correct EBCM will result in a system malfunction.



Remove or Disconnect (Figure 8)

NOTICE: Do not touch the electrical connections and pins or allow them to come in contact with brake fluid as this will damage the EBCM.

1. Electrical connectors from the EBCM.
2. EBCM.
 - Pull the EBCM toward the front of the vehicle.



Install or Connect (Figure 8)

NOTICE: Do not touch the electrical connections and pins or allow them to come in contact with brake fluid as this will damage the EBCM.

1. EBCM.
 - Slide the EBCM into the bracket until the tab locks in the hole.
2. Electrical connectors to the EBCM.
 - If there is brake fluid on the connectors, clean them with water followed by denatured alcohol.

ANTILOCK PRESSURE VALVE

The antilock pressure valve is not serviceable. It should be replaced when the DTC charts show that it is the cause of a malfunction.



Remove or Disconnect (Figure 8)

1. Brake pipe fittings from the antilock pressure valve.
2. Bottom electrical connector from the EBCM.
 - Do not allow the antilock pressure valve to hang by the wiring harness.

NOTICE: Do not touch the electrical connections and pins or allow them to come into contact with brake fluid as this will damage the EBCM.

3. Antilock pressure valve mounting bolts.

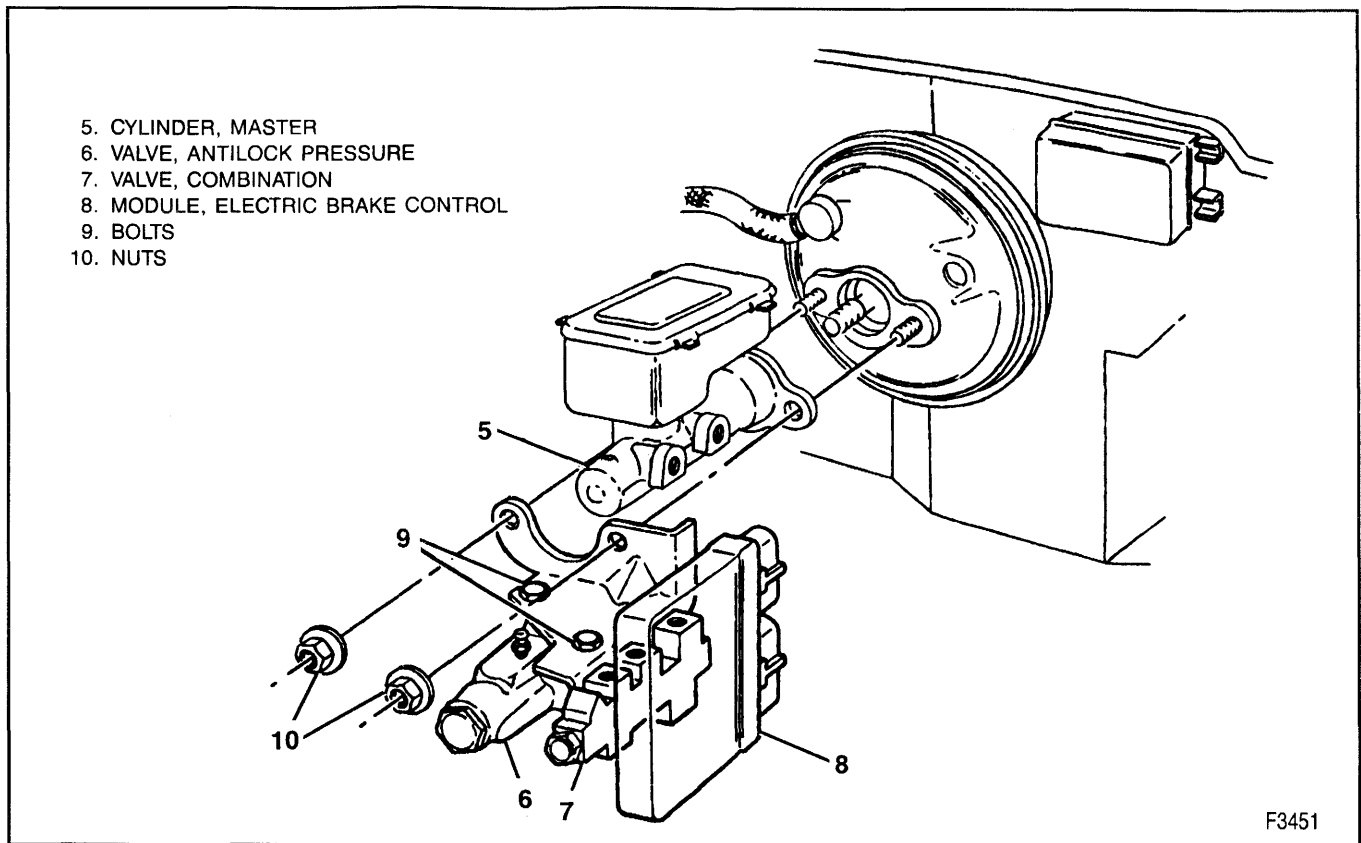


Figure 8—EBCM and Antilock Pressure Valve

4. Antilock pressure valve.

Install or Connect (Figure 8)

1. Antilock pressure valve.

NOTICE: Refer to "NOTICE" on page 5E3-1.

2. Antilock pressure valve mounting bolts.

Tighten

- Antilock pressure valve mounting bolts to 29 N.m (21 lbs. ft.).

NOTICE: Do not touch the electrical connections and pins or allow them to come into contact with brake fluid as this will damage the EBCM.

3. Electrical connector to the EBCM.

- If there is brake fluid on the connectors, clean them with water followed by denatured alcohol.

4. Brake pipes to the antilock pressure valve.

Tighten

- Antilock pressure valve brake pipe fittings to 24 N.m (18 lbs. ft.).

5. Bleed the system. Refer to "Bleeding System."

VEHICLE SPEED SENSOR

The vehicle speed sensor (VSS) is not serviceable. It should be replaced when necessary. Refer to SECTION 7 for replacement procedures.

WARNING LAMP

For warning lamp on-vehicle service information, refer to SECTION 8C.

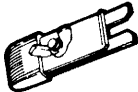
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Ft. Lbs.
Antilock Pressure Valve Mounting Bolts	29	21
Brake Pipe Fittings	24	18
		T2566

SPECIAL TOOLS

1.



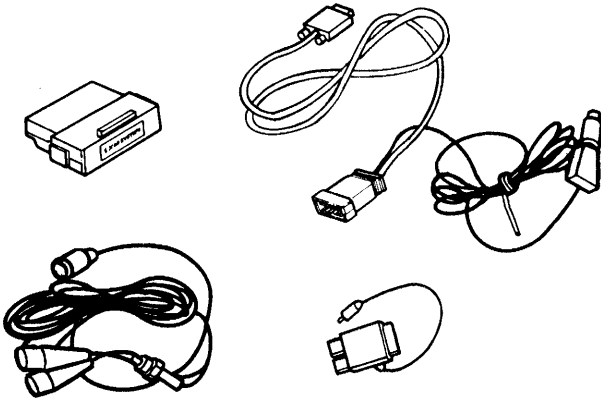
J 39177

2.



TK 00000

3.



TK 02650 (4 PIECES)

- 1. COMBINATION VALVE PRESSURE BLEEDING TOOL
- 2. TECH-1 SCAN TOOL
- 3. RWAL/4WAL CARTRIDGE KIT

SECTION 5F

PARKING BRAKE

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, by cleaning brake parts with a dry brush or with compressed air. Many earlier model or aftermarket brake parts may contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. the correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

There are three basic types of parking brakes used on the C/K models. The lower GVW models use leading/trailing rear drum brakes. The higher GVW models use duo-servo rear drum brakes. The highest GVW model (C3HD) has a propeller shaft parking brake mounted on the transmission.

LEVER

The parking brake lever is located on the left side of the driver's compartment and is activated by foot pressure. The lever assembly has a ratchet mechanism in it to allow varying degrees of parking brake application. The parking brake handle on the instrument panel allows the driver to release the parking brake.

CABLE SYSTEM

The cable system will vary depending on the type of parking brake system used.

Models with rear drum brakes used a system that includes one front cable and two rear cables. The front cable connects to the lever on one end and the equalizer on the other end. The rear cables attach to the

equalizer on one end and the parking brake struts in the drum brakes on the other end.

Models with a propeller shaft parking brake use a one-cable system. The cable connects to the front lever on one end and the rear lever on the other end.

"BRAKE" LAMP

The "BRAKE" warning lamp on the instrument cluster turns on when the parking brake is applied. The BRAKE lamp can also be turned on by the switch in the combination valve and the antilock brake system.

PARKING BRAKE SWITCH

The parking brake switch is located on the lever assembly. The switch serves as the device to turn on the "BRAKE" lamp when the parking brake is applied and turn it off when the parking brake is released.

DAYTIME RUNNING LIGHTS

Canadian vehicles use a daytime running light (DRL) system. This system uses the parking brake switch to turn the headlamps off when the ignition switch is "ON" and the parking brake applied. For more information on DRL, refer to SECTION 8B.

DIAGNOSIS

CABLE INSPECTION

Check the parking brake for free operation. The brake lever must return to the released position without sticking or binding. If a problem is present, check the cable routings for kinks or binding.

LINING INSPECTION

Replace brake shoe and lining assemblies whenever the thickness of any lining is worn to within 0.76 mm (0.030 in.) of the shoe. For riveted shoe and lining assemblies, replace when the lining is worn to within 0.76 mm (0.030 in.) of any rivet head.

DRUM INSPECTION

Any time the parking brake drum is removed, thoroughly clean and inspect it for cracks, scores, deep grooves, and out-of-round.

SURFACE FINISH

Slight scoring can be cleaned up with fine emery cloth. Heavy or extensive scoring causes excessive brake lining wear. The drum braking surface will need machining to remove these scores.

If the drum is grooved and the brake linings are slightly worn, the drum should not be machined. Instead, polish the drum braking surface with fine emery cloth. Eliminating all of the drum grooves and ridges on the lining would require removing too much metal and lining material. The grooves and ridges match and satisfactory service can be obtained by leaving them alone.

INSIDE DIAMETER CHECK

Measure the inside diameter of the brake drum at two or more places around the circumference of the braking surface. The measurements must be made at the same distance in from the the edge of the drum.

TAPER CHECK

Measuring a drum for taper involves taking measurements at the inner and outer edges of the machined surface at two or more places around the drum.

ON-VEHICLE SERVICE

LUBRICATION

Clean and lubricate the parking brake assembly and cables with Lubriplate (GM P/N 1050109) or equivalent. Do not allow the lubricant to contact the drum or lining surfaces.

LEVER

↔ Remove or Disconnect (Figure 1)

- The C3HD lever looks the same as the other models, but uses a different torque applying lever assembly.
- The parking brake must be fully released.

1. Lower instrument panel section. Refer to SECTION 10A4.
2. Connector from parking brake switch.
3. Release cable (2).
4. Handle (3).
5. Bolts (4).
6. Lever assembly (1).

→↔ Install or Connect (Figure 1)

1. Lever assembly (1).

NOTICE: Refer to "Notice" on page 5F-1.

2. Bolts (4).



Tighten

- Bolts (4) to 24 N·m (18 lbs. ft.).

3. Handle (3).
4. Release cable (2).
5. Connector to parking brake switch.
6. Dash assembly. Refer to SECTION 8C.



Adjust

- Refer to "Adjustment" in this section.

CABLES

FRONT CABLE

↔ Remove or Disconnect (Figure 2)

1. Raise vehicle and support with safety stands.
2. Loosen adjusting nut (13) at equalizer (12) (figure 3).
3. Connector (8).
4. Cable (5) from parking brake lever (1).
 - Bend in the retaining fingers (6) at the frame bracket.
5. Front cable (5).

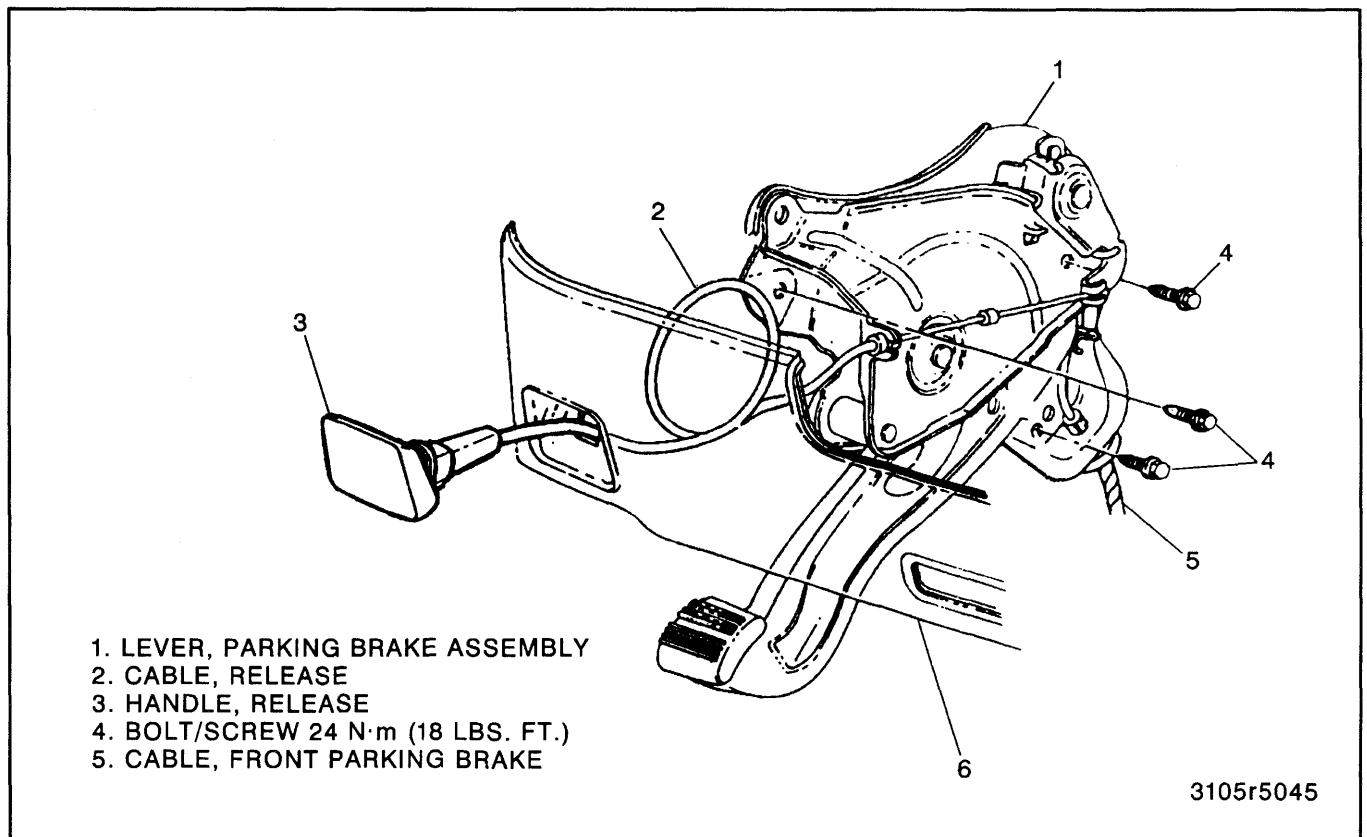


Figure 1—Parking Brake Lever

5F-4 PARKING BRAKE

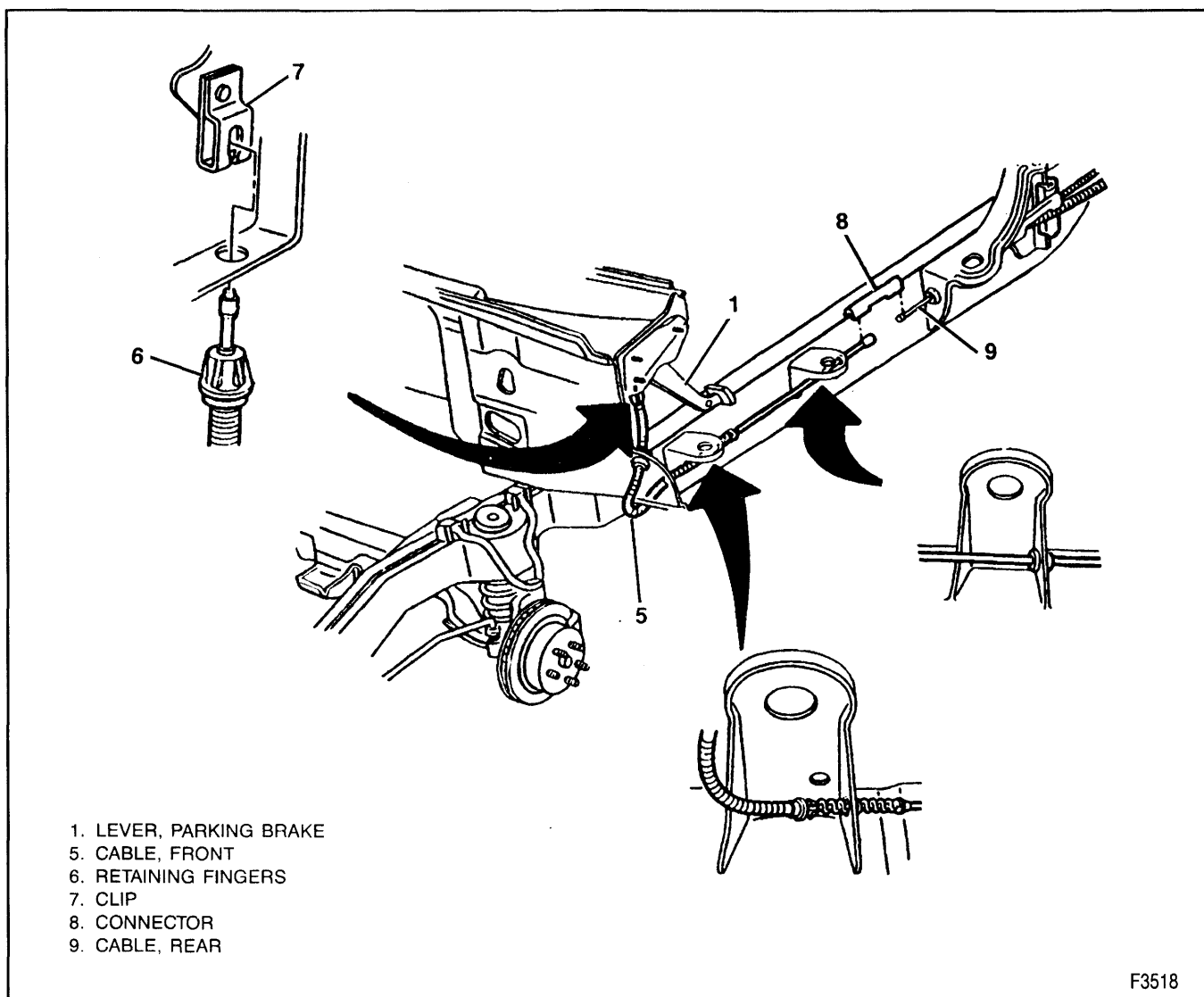


Figure 2—Front Parking Brake Cable

Install or Connect (Figure 2)

1. Front cable (5).
2. Cable (5) to parking brake lever (1).
 - Make sure all retaining fingers (6) are through the hole.
3. Connector (8).

Adjust

- Refer to "Adjustment" in this section.

REAR CABLES

Remove or Disconnect (Figure 3)

1. Release parking brake.
2. Raise vehicle and support with safety stands.
3. Loosen nut (13) at equalizer (12).
4. Connector (8).
5. Rear brake assembly. Refer to SECTION 5C1 or 5C2.
6. Bend in the retaining fingers at the backing plate.

7. Cable (10 or 11).

Install or Connect (Figure 3)

1. Cable (10 or 11).
2. Cable end into backing plate.
 - Make sure all retaining fingers are completely through the backing plate.
3. Rear brake assembly. Refer to SECTION 5C1 or 5C2.
4. Connector (8).

Adjust

- Refer to "Adjustment" in this section.

ADJUSTMENT

The parking brake must be adjusted any time the parking brake cables are serviced, or the holding ability is not adequate. Before adjusting the parking brake, check the condition of the service brakes. The service brakes must be adjusted properly before adjusting the parking brake. Refer to SECTION 5C1 or 5C2.

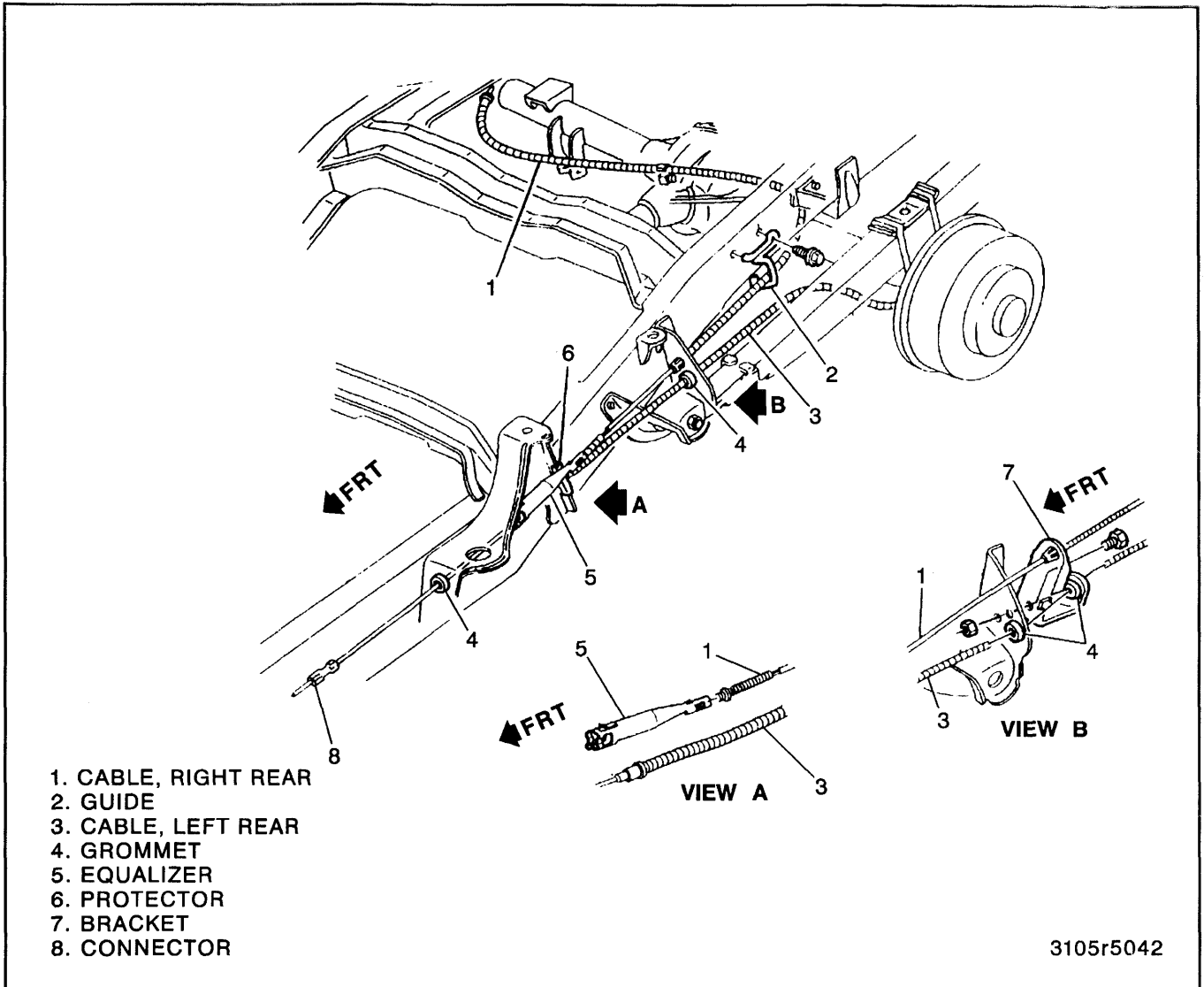


Figure 3—Rear Parking Brake Cable

The C3HD has a propeller shaft mounted parking brake and does not affect the service brakes.

DUO-SERVO DRUM BRAKES



Adjust (Figure 3)

1. Block the front wheels.
2. Raise the vehicle and support with safety stands.
3. Loosen the adjusting nut (13).
4. Set the parking brake by pushing the pedal down 22 degrees.
5. Turn adjusting nut until wheels rotate forward with moderate drag.
6. Release parking brake and rotate rear wheels.
 - There should be no drag.
7. Lower the vehicle and unblock front wheels.

LEADING/TRAILING DRUM BRAKES



Remove or Disconnect (Figures 4, 5, and 6)

Tool Required:

J 21177-A Drum to Brake Shoe Clearance Gage

1. Block the front wheels.
2. Raise the vehicle and support with safety stands.
3. Mark the relationship of the wheel to the axle flange.
4. Remove the wheel and tire.
5. Mark the relationship of the drum to the axle flange.
6. Remove the drum.
7. Measure the drum's inside diameter (A) using J 21177-A (figure 6).
8. Turn adjuster nut (23) until lining diameter is 0.254 to 0.508 mm (0.010 to 0.020 in.) less than drum ID (B) for each rear wheel.
9. Make sure the stops on the park brake levers are against the edge of the shoe web.
 - If the parking brake cable is holding the stops off the edge of the shoe web, loosen the parking brake cable adjustment.
10. Tighten the parking brake cable adjuster nut until the lever stops begin to move off the shoe webs.

5F-6 PARKING BRAKE

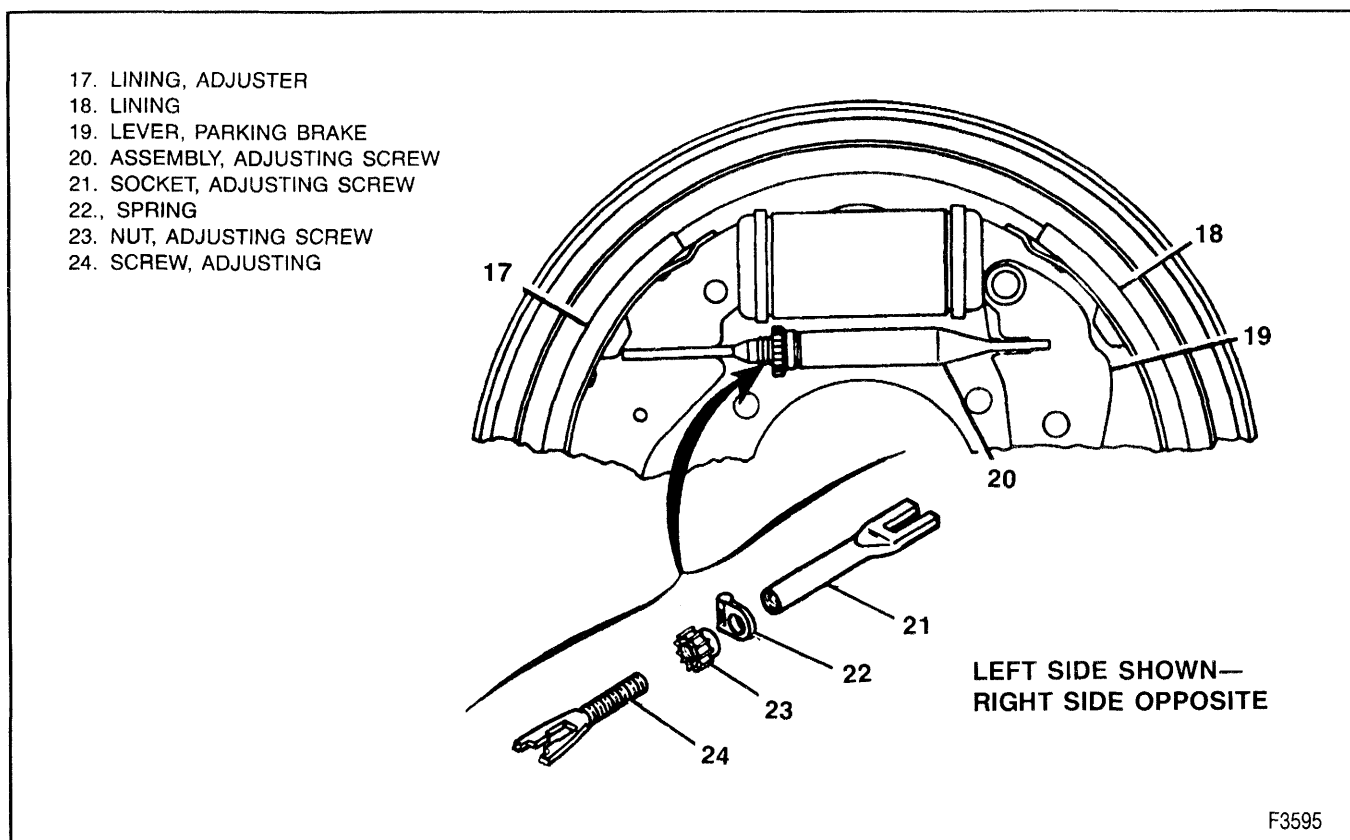
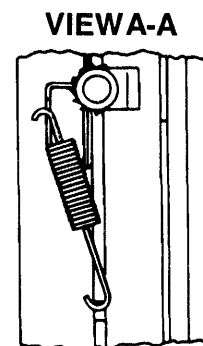
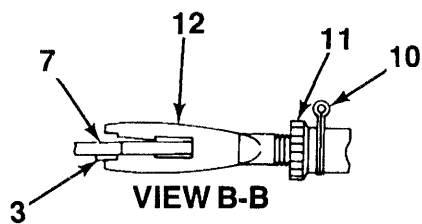
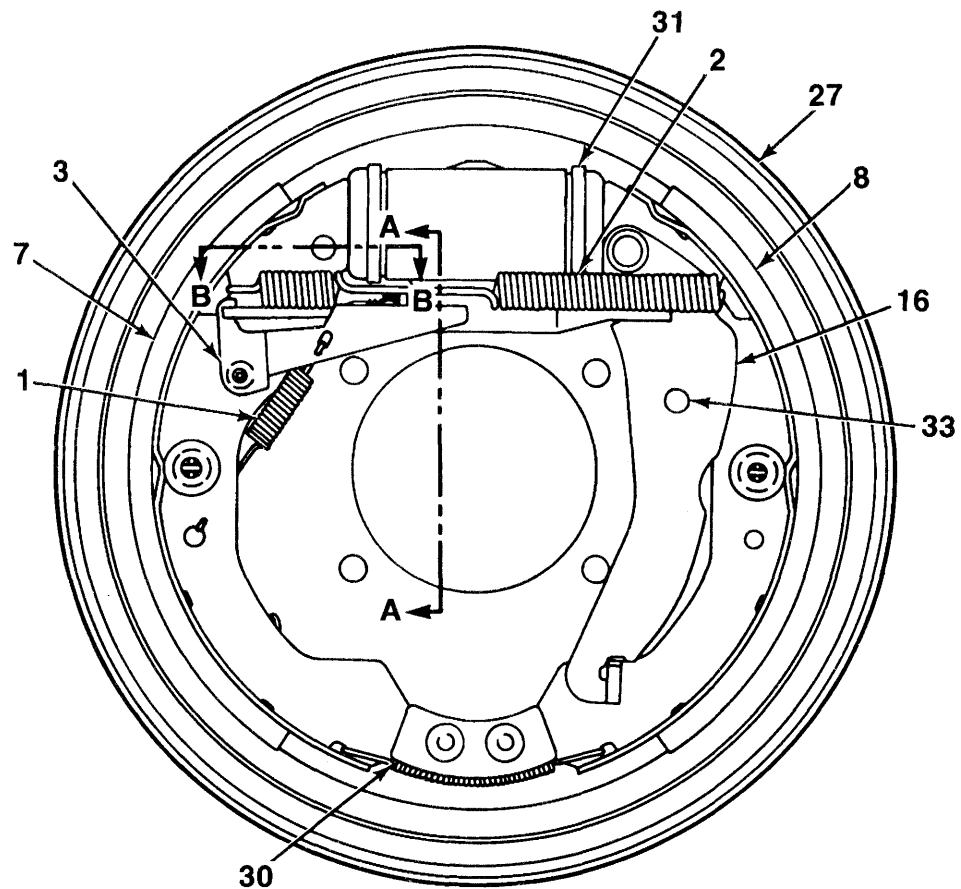


Figure 4—Adjusting Screw Assembly (Leading/Trailing)

11. Loosen the adjuster nut until the lever stops move back to barely touch the shoe webs.
 - There should be no more than 0.5 mm (0.020 in.) clearance between stops and either web.
12. Install drums and wheels, aligning the previous marks.
13. Apply and release the service brake pedal 30 to 35 times with normal pedal force.
 - Pause about one second between pedal applications.
14. Apply parking brake.
 - The rear wheels should not rotate.
15. Release parking brake and check for free wheel rotation.
16. Lower the vehicle.
17. Tighten lug nuts. Refer to SECTION 3E.

“BRAKE” LAMP

For “BRAKE” lamp on vehicle service, refer to SECTION 8C.



- | | |
|------------------------|-----------------------------|
| 1. Actuator Spring | 12. Adjuster Screw |
| 2. Upper Return Spring | 16. Park Brake Lever |
| 3. Adjuster Actuator | 27. Backing Plate |
| 7. Shoe & Lining | 30. Anchor Plate |
| 8. Shoe & Lining | 31. Wheel Cylinder Assembly |
| 10. Spring Clip | 33. Lever Stop |
| 11. Adjuster Nut | |

F6881

Figure 5—Parking Brake Adjustment (Left Leading/Trailing)

5F-8 PARKING BRAKE

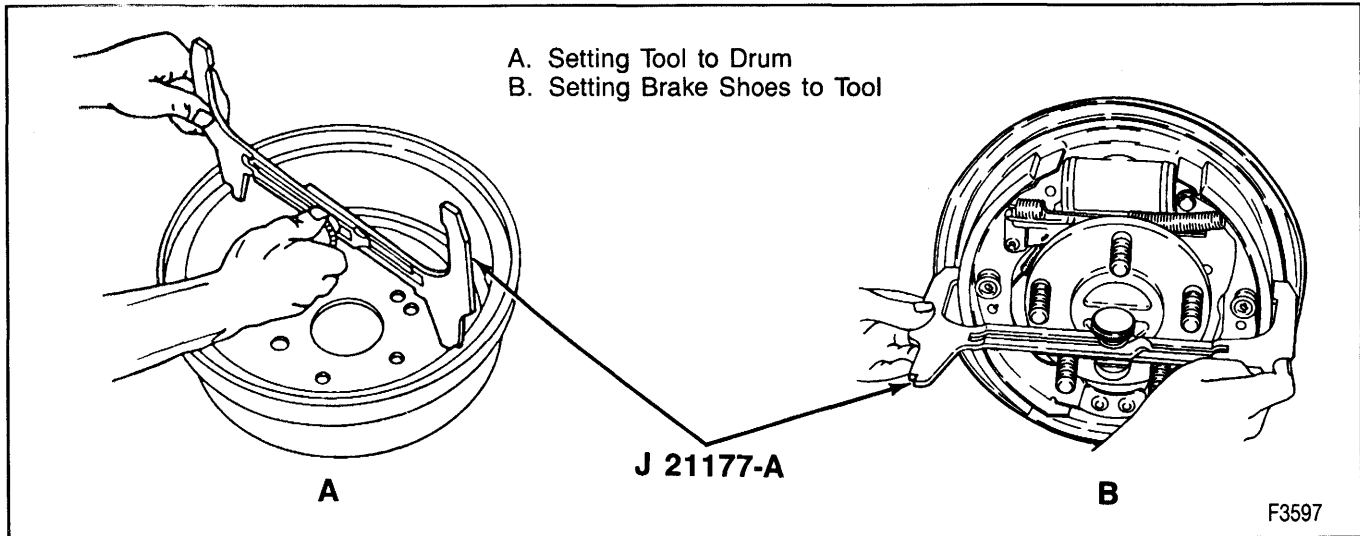


Figure 6—Measuring the Drum for Fit (Leading/Trailing)

ON-VEHICLE SERVICE: PROPELLER SHAFT PARKING BRAKE

CABLE

↔ Remove or Disconnect (Figure 7)

1. Release the parking brake.
2. Raise the vehicle and support with safety stands.
3. Cotter pin (4) and clevis pin (3).
4. Clevis (5) and nut (6) from cable.
5. Grommet (7) from bracket.
6. Bolt (8) and clip (9).
7. Cable end from lever (13).
8. Retaining fingers (12) from lever (13).
9. Cable assembly (10).

↔ Install or Connect (Figure 7)

1. Cable assembly (10).
2. Retaining fingers (12) to lever (13).
3. Cable end to lever (13).
4. Grommet (7) to bracket.

NOTICE: Refer to "Notice" on page 5F-1.

5. Clip (9) and bolt (8).

Tighten

- Bolt (8) to 10 N·m (88 lbs. in.).
6. Nut (6) and clevis (5) to cable, finger tight.
 7. Adjust. Refer to "Adjustment" in this section.
 8. Lower the vehicle.

ADJUSTMENT

Adjust (Figures 7 and 8)

Tool Required:
J 35999 Fish Scale

1. Remove clevis pin (3) from lever (2).
2. Set parking brake by pushing the pedal down 22 degrees.
3. Install J 35999 with a small length of cable or chain, and a tightening device (like a turn buckle) on the frame.
4. Install a small chain (A) on the lever (2) near the spring (23) on the bottom of the lever.
5. Tighten the tightening device until J 35999 is at 222 N (50 lbs.).
6. Loosen nut (6) and turn the clevis (5) until the pin (3) slides freely in the lever (2) with all slack removed from the cable.
7. Install clevis pin (3) and cotter pin (4).

Tighten

- Nut (6) to 37 N·m (27 lbs. ft.)

8. Remove J 35999 and all extensions used.
9. Release the parking brake.

DRUM REPLACEMENT

↔ Remove or Disconnect (Figures 9 and 10)

1. Release the parking brake.
2. Raise the vehicle and support with safety stands.
3. Propeller shaft. Refer to SECTION 4A.
4. Nut (14) or bolt (17) and washer (15 or 16).
5. Drum and yoke assembly (18).
6. Bolts (22) and washers (21).
7. Drum (18) from yoke (20).

↔ Install or Connect (Figures 9 and 10)

NOTICE: For steps 2 and 4, refer to "Notice" on page 5F-1.

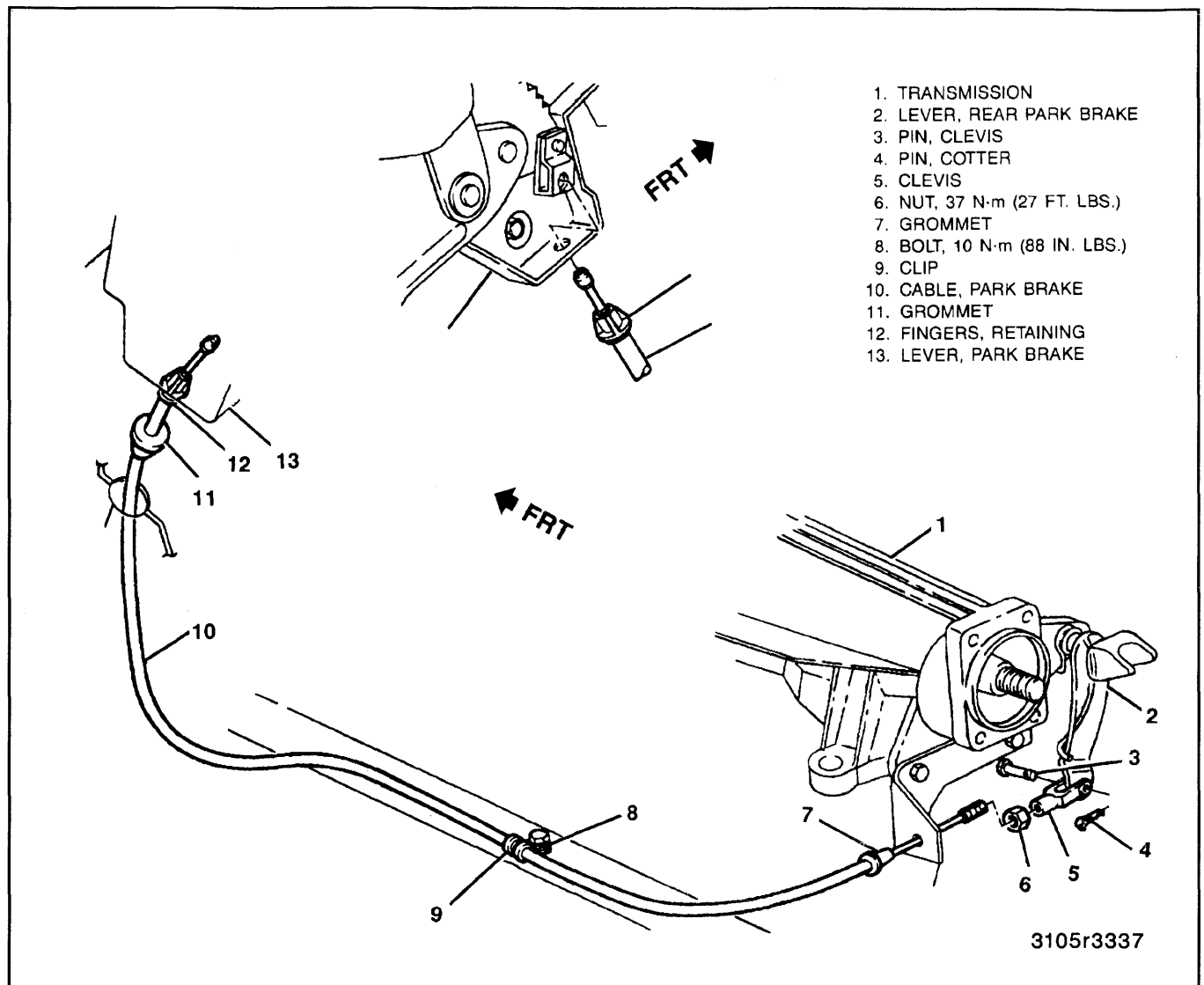


Figure 7—Parking Brake Cable

1. Drum (18) to yoke (20).
2. Bolts (22) and washers (21).



Tighten

- Bolts (22) to 37 N·m (27 lbs. ft.)
- 3. Drum and yoke assembly.
- 4. Washer (15 or 16) and nut (14) or bolt (17).



Tighten

- Nut (14) to 255 N·m (180 lbs. ft.).
- Bolt (17) to 88 N·m (65 lbs. ft.).
- 5. Propeller shaft. Refer to SECTION 4A.
- 6. Lower the vehicle.

LINING REPLACEMENT



Remove or Disconnect (Figures 11 and 12)

1. Drum. Refer to "Drum Replacement" in this section.
2. Bolts (26) and washers (25).

3. Support plate (24) and shoe kits (19).
4. Springs (27, 28, and 29).
5. Shoe kits (19).



Inspect

- Springs for signs of wear or excessive heat. Replace as needed.
- Support plate friction points for wear. Replace if wear is excessive.



Install or Connect (Figures 11 and 12)

1. Shoe kits (19) to support plate (24).
2. Springs (27, 28, and 29).
3. Support plate (24) and shoe kits (19).
- Index lever (2) between shoes.

NOTICE: Refer to "Notice" on page 5F-1.

4. Bolts (26) and washers (25).

5F-10 PARKING BRAKE

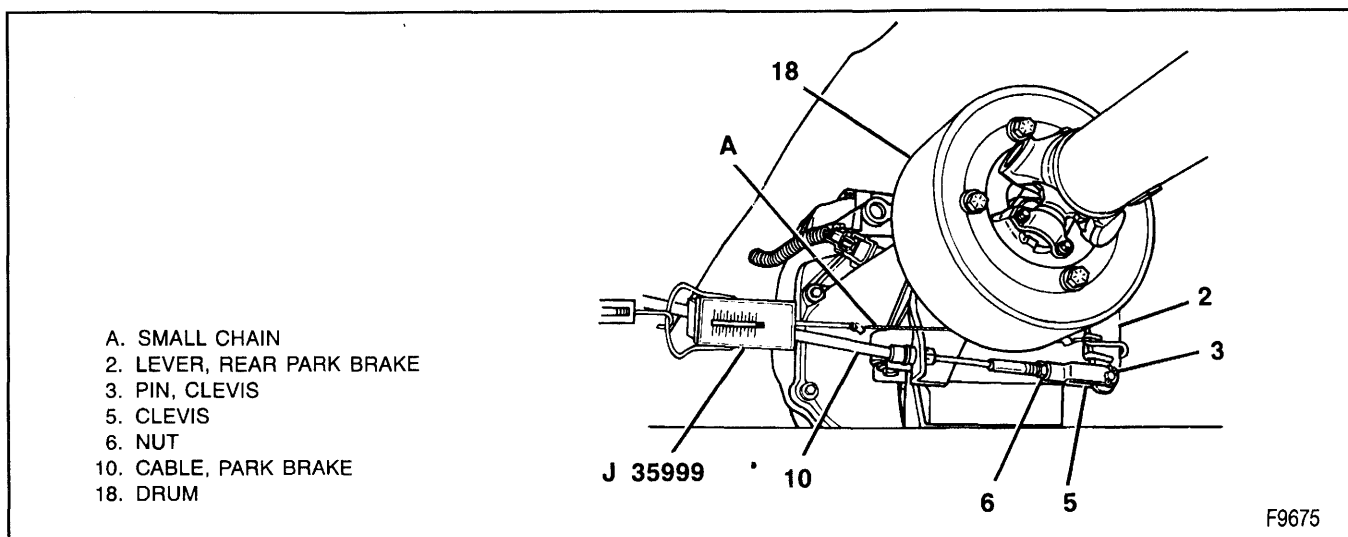


Figure 8—Parking Brake Adjustment

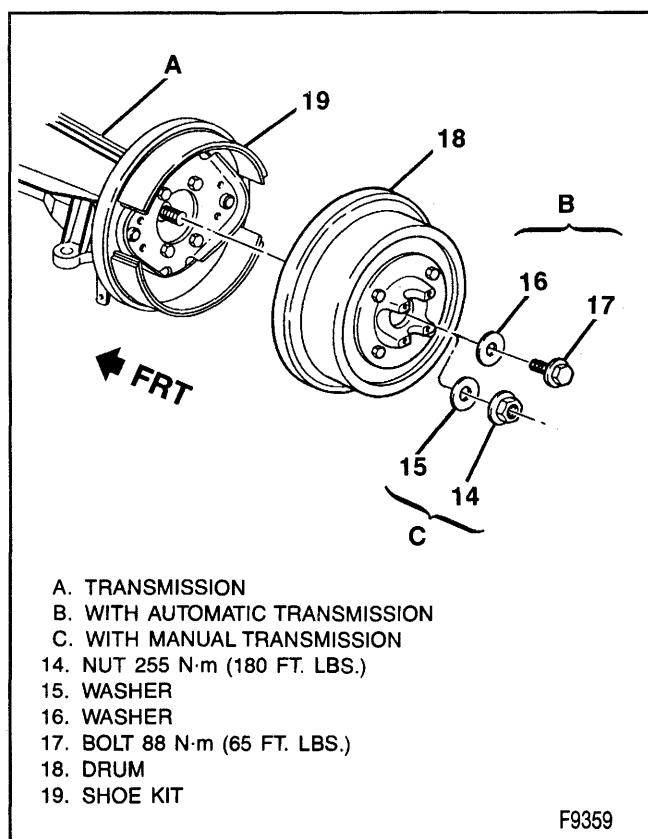


Figure 9—Drum Replacement

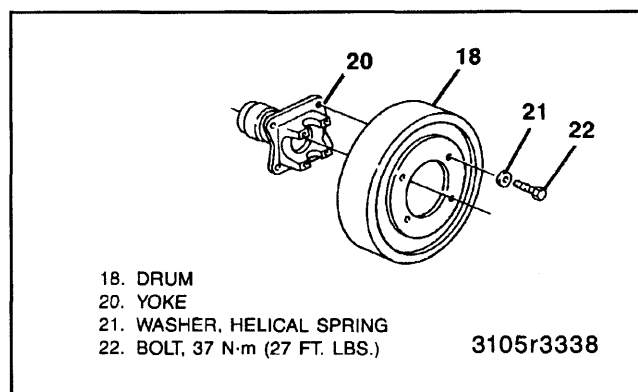


Figure 10—Drum and Yoke



Tighten

- Bolts (26) to 105 N·m (77 lbs. ft.).
- 5. Drum. Refer to "Drum Replacement" in this section.

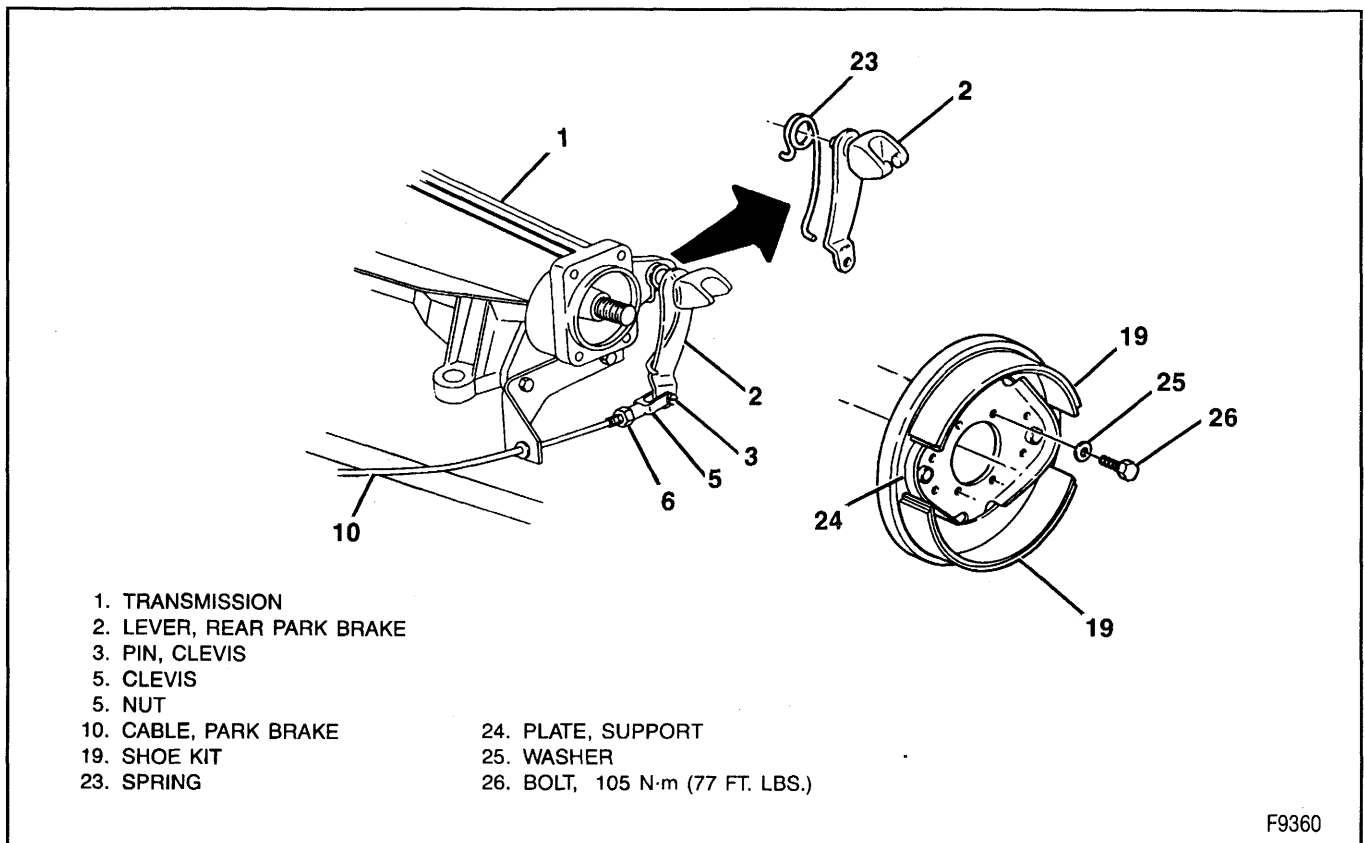


Figure 11—Parking Brake Components

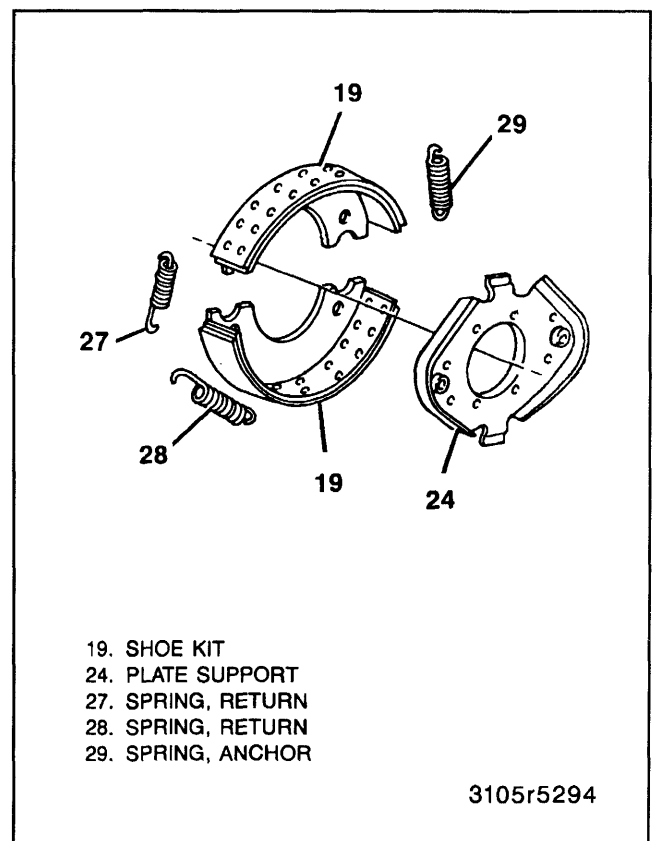


Figure 12—Lining Replacement

5F-12 PARKING BRAKE

SPECIFICATIONS BRAKE SYSTEMS

SYSTEM	FRONT BRAKES	REAR BRAKES	BRAKE ASSIST
JB5	Disc 11.57-inch x 1.25-inch	254 mm x 57 mm (Leading/Trailing)	Vacuum
JD5			Hydraulic
JB6	Disc 11.57-inch x 1.25-inch	11.15-inch x 2.75-inch (Duo-Servo)	Vacuum
JD6			Hydraulic
JB7	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Vacuum
JD7			Hydraulic
JB8 Single Rear Wheel	Disc 12.5-inch x 1.26-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JB8 Dual Wheel	Disc 12.5-inch x 1.50-inch	13.00-inch x 3.5-inch (Duo-Servo)	Hydraulic
JF9	Disc 14.25-inch x 1.54-inch	Disc 13.75 inch x 1.54 inch	Hydraulic

T2112

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Ft. Lbs.	In. Lbs.
Cable Clevis Jam Nut.....	37	27	—
Cable Clip Bolt.....	10	—	88
Drum to Yoke Bolts.....	37	27	—
Parking Brake Lever Mounting Bolts.....	24	18	—
Support Plate Mounting Bolts.....	105	77	—
Yoke Shaft Bolt.....	88	65	—
Yoke Shaft Nut.....	255	180	—

T2946

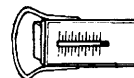
SPECIAL TOOLS

1.



J 21177-A

2.



J 35999

1. Drum to Brake Shoe Clearance Gage
2. Fish Scale

F9793

ENGINE

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SECTION 6

GENERAL INFORMATION

Following are brief outlines of the information contained in Section 6. Use them as a guide to help locate information more quickly.

SECTION 6A ENGINE, DRIVEABILITY, AND DIAGNOSIS

This section contains information common to all engines, including:

- Use of gasket sealers
- Diagnosis (for engine mechanical)
- Compression check procedure
- Oil leak diagnosis

SECTIONS 6A3 THROUGH 6A6 4.3L V6, 5.0L AND 5.7L V8, 7.4L V8, AND 6.5L DIESEL

These sections contain information for on-vehicle servicing of the basic engine, such as manifold, cylinder head, camshaft, and piston replacement.

Detailed repair information on components such as oil pump, cylinder head, etc. is not included. Refer to the Light Duty Truck Unit Repair Manual for this information.

SECTION 6B1 ENGINE COOLING

This section has information on cooling system components, including:

- Diagnosis
- Coolant Pump
- Fan and Fan Clutch
- Auxiliary Fan
- Belts
- Thermostat

SECTION 6B2 RADIATOR

This section contains information on radiators and shrouds, including aluminum radiator repair procedures.

6-2 ENGINE

SECTION 6C FUEL SYSTEM

This section contains information on diesel engine fuel system components, including:

- Accelerator controls
- Fuel tanks
- Air cleaners

For information on gasoline engine fuel systems and diesel engines with electronic engine controls (ECM). Refer to the Driveability, Emissions, and Electrical Diagnosis Manual NATP-9442.

SECTION 6C2 DIESEL FUEL INJECTION

This section contains information on the mechanical fuel injection system used on some diesel engines, including:

- Timing adjustment and other adjustment procedures.
- Injection nozzle replacement and testing.
- Injection pump replacement and repairs.

For information on diesel engines with electronically controlled fuel injection systems, refer to the Driveability, Emissions, and Electrical Diagnosis Manual NATP-9442.

SECTION 6D ENGINE ELECTRICAL

This section contains information on electrical components associated with engine operation, including:

- Spark plug wires
- Battery
- Glow plug system
- Starters
- Generators
- Distributors
- Engine Wiring

On-vehicle service procedures are given. For overhaul information, refer to the Light Duty Truck Unit Repair Manual.

SECTION 6E EMISSIONS

For information on throttle body fuel injection (TBI) emissions systems, refer to the Driveability, Emissions, and Electrical Diagnosis Manual NATP-9442.

SECTION 6E2 DIESEL EMISSIONS

This section contains information on the emissions systems of diesel engines with mechanical injection pumps, including component repair. Driveability diagnosis can be found in SECTION 6A.

For diesel engines with electronically controlled injection pumps, refer to the Driveability, Emissions, and Electrical Diagnosis Manual NATP-9442.

SECTION 6F EXHAUST SYSTEM

This section contains information on the exhaust system, including component replacement.

SECTION 6H VACUUM PUMPS

This section contains information on vacuum pumps, including replacement procedures and diagnosis.

SECTION 6J TURBOCHARGER

This section contains information on the diesel engine turbocharger, including diagnosis and component replacement.

For information on the diesel engine turbochargers with electronic controls (if equipped), refer to the Driveability, Emissions, and Electrical Diagnosis Manual NATP-9442.

SECTION 6A**ENGINE, DRIVEABILITY, AND
DIAGNOSIS**

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL INFORMATION**STATEMENT ON CLEANLINESS
AND CARE**

- An engine is a combination of many machined, honed, polished, and lapped surfaces with very fine tolerances.
- Whenever valve train components, cylinder head, cylinder block, crankshaft, or connecting rod components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.
- Any time the air cleaner or TBI unit is removed, the intake opening must be covered. If a diesel engine is being serviced, the recommended cover set (J 29664) should be used. This will protect against the entrance of foreign material which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.
- When any internal engine parts are serviced, care and cleanliness are important. Apply a liberal coating of engine oil to friction areas during assembly to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of

6A-2 ENGINE, DRIVEABILITY, AND DIAGNOSIS

machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

- On diesel engines, whenever the fuel injection pump or lines are removed or disconnected, take care to prevent the entry of dirt into the pump, lines, and injectors. The entry of even a small amount of dirt or other foreign material into the fuel injection system may cause serious damage.
- It should be kept in mind, while working on the engine, that the 12-volt electrical system is capable of violent and damaging short circuits. When performing any work where electrical terminals could possibly be grounded, disconnect the ground cable of the battery at the battery.
- Disconnect battery cables before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.
- Cover or otherwise protect exposed electrical connections to prevent damage from oil and fuel.
- When raising and supporting the engine for any reason, do not use a jack under the oil pan. Due to the small clearance between the oil pan and oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

TUNE-UP INFORMATION

All information required to tune up the vehicle's engine is given on the Engine Emission Control Label located in the engine compartment.

Information that can be found on the label includes:

- Engine displacement.
- Timing specifications.
- Spark plug gap.
- Timing adjustment procedures.
- Emission hose routing.

USE OF RTV SEALER AND ANAEROBIC GASKET ELIMINATOR

Two types of sealer are commonly used in engines covered by this manual. These are RTV sealer and anaerobic "gasket eliminator" sealer.

It is important that these sealers be applied properly and in the proper place to prevent oil leaks. THE TWO TYPES OF SEALER ARE NOT INTERCHANGEABLE. Use the sealer recommended in the procedure.

- RTV (room temperature vulcanizing) sealer is used where a non-rigid part is assembled to a rigid part. Common examples are oil pans and rocker arm covers.

- Anaerobic gasket eliminator hardens in the absence of air. This sealer is used where two rigid parts (such as castings) are assembled together. When two rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using gasket eliminator.

USING RTV SEALER

1. Don't use RTV where extreme temperatures are expected, such as exhaust manifold, head gasket, or where gasket eliminator is specified.
2. When separating components sealed with RTV, use a rubber mallet and "bump" the part sideways to shear the RTV sealer. "Bumping" should be done at bends or reinforced areas to prevent distortion of parts. RTV is weaker in shear (lateral) strength than in tensile (vertical) strength.

NOTICE: Attempting to pry or pull components apart may cause damage to the part.

3. Surfaces to be resealed must be clean and dry. Remove all traces of oil and RTV. Clean with a chlorinated solvent (GM P/N 1050454) or equivalent. Don't use petroleum-based cleaners such as mineral spirits. They leave a film onto which RTV won't stick.
4. Apply RTV to one of the clean surfaces. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer in any blind threaded holes, as it may prevent the bolt from seating properly or cause damage when the bolt is tightened.
5. Assemble while RTV is still wet within 3 minutes. Don't wait for RTV to skin over.
6. Tighten bolts to specifications. Don't overtighten.

USING ANAEROBIC GASKET ELIMINATOR

1. Clean surfaces to be resealed with a chlorinated solvent (GM P/N 1050454 or equivalent), to remove oil, grease, and old material.
2. Apply a continuous bead of gasket eliminator to one flange.
3. Spread bead evenly with your finger to get a uniform coating on the complete flange.
4. Assemble parts in the normal manner and tighten fasteners to specifications.

REPLACING ENGINE GASKETS

CAUTION: Composite type gaskets are used in some areas of the engine assembly. These gaskets have a thin metal core. Use caution when removing or handling composite gaskets to help avoid personal injury.

COMPRESSION/CRANKING SPEED CHECKS

GASOLINE ENGINE COMPRESSION CHECK

1. Disconnect the primary lead from the distributor or ignition coil. Refer to SECTION 6D4.
2. Remove all spark plugs.

3. Block the throttle plate wide open.
4. Make sure the battery is fully charged.
5. Starting with the compression gage at zero, crank the engine through four compression strokes (four "puffs").

6. Make the compression check at each cylinder and record each reading.
7. If some cylinders have low compression, inject about 15 ml (1 tablespoon or about 3 squirts from a pump type oil can) of engine oil into the combustion chamber through the spark plug hole.
8. Minimum compression recorded in any one cylinder should not be less than 70 percent of highest cylinder, and no cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any one cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1035 \times 70\% = 725$) ($150 \times 70\% = 105$).

- Normal—Compression builds up quickly and evenly to specified compression in each cylinder.
- Piston Rings Leaking—Compression low on first stroke tends to build up on following strokes but does not reach normal. Improves considerably with addition of oil.
- Valves Leaking—Low on first stroke. Does not tend to build up on following strokes. Does not improve much with addition of oil.
- If two adjacent cylinders have lower than normal compression, and injecting oil into cylinders does not increase the compression, the cause may be a head gasket leak between the cylinders.

DIESEL ENGINE COMPRESSION CHECK

Tools Required:

- J 29664 Cover Set
- J 26999 Compression Gage
- J 26999-10 Compression Gage Adapter

1. Remove the air cleaner. Cover the opening in the intake manifold with J 29664.
2. Disconnect the pink wire (1) from the fuel solenoid terminal of the injection pump (figure 1).
3. Disconnect wires from glow plugs, then remove all glow plugs.

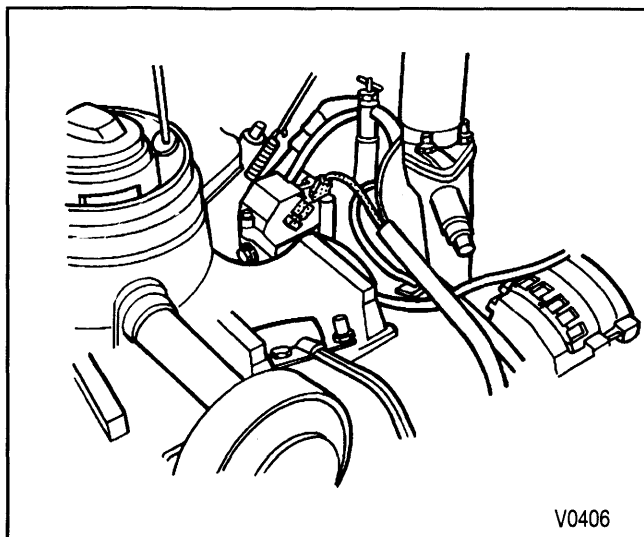


Figure 1—Fuel Solenoid Wire

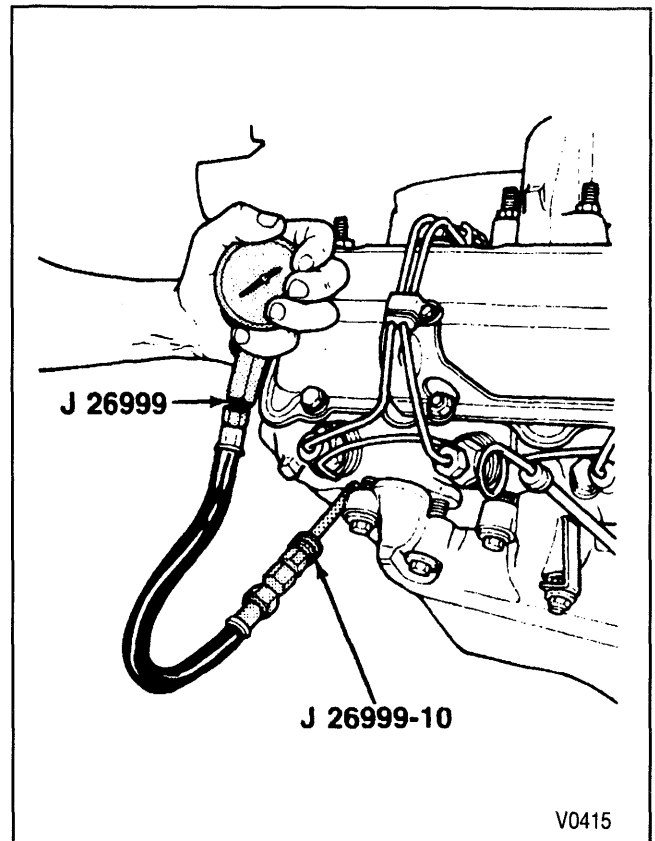


Figure 2—Checking Diesel Engine Compression

4. Screw J 26999-10 into the glow plug hole of the cylinder that is being checked. Connect to J 26999 (figure 2).
5. Make sure the batteries are fully charged, and the engine is fully warmed up (engine oil hot).
6. Crank the engine. Allow six "puffs" per cylinder.
7. Make the compression check at each cylinder and record the readings.

NOTICE: Do not add oil to any cylinder during a compression test as extensive engine damage can result.

8. The lowest reading cylinder should not be less than 80 percent of the highest reading cylinder. No cylinder should read less than 2625 kPa (380 psi).
 - Normal: Compression builds up quickly and evenly to specified compression on each cylinder. Reading should be in the 2625-2760 kPa (380-400 psi) range.
 - Leaking: Compression low on first stroke, tends to build up on following strokes but does not reach normal.

CRANKING SPEED CHECK (DIESEL ENGINE)

Tool Required:

- J 26999 Compression Gage
- J 26999-10 Compression Gage

Cranking speed is critical for a diesel engine to start, either hot or cold. Some tachometers are not accurate at cranking speed. An alternate method of checking

6A-4 ENGINE, DRIVEABILITY, AND DIAGNOSIS

cranking speed or determining the accuracy of a tachometer follows:

1. Screw J 26999-10 into any cylinder and connect J 26999 compression gage.
2. Disconnect the injection pump fuel solenoid lead on the top of the injection pump (figure 1).
3. Install the digital tachometer.
4. Depress the pressure release valve on the compression gage.
5. With aid of an assistant, crank the engine for 2 or 3 seconds to allow the starter to reach full speed, then without stopping, count the number of "puffs" at the compression gage that occur in the next 10

seconds. Multiply the number of "puffs" in the 10 second period by 12 and the resulting number will be the engine speed.

Example:

10 seconds= 1/6 of a minute

1 puff= Engine speed of 2

Engine speed= No. of puffs x 2 x 6 or

Engine speed= No. of puffs x 12

Minimum cranking speed on the 6.5L diesel engine is 100 RPM cold and 180 RPM hot. The actual cranking speed needed will vary depending on the condition of the engine (compression) and nozzles.

DIAGNOSIS CHARTS

DIESEL ENGINE DIAGNOSIS

The diesel engine diagnosis charts cover the areas of mechanical/maintenance, electrical/emissions, and air system (figures 3 through 6).

DIAGNOSIS OF DIESEL ENGINE

Figure 3—Diesel Engine Diagnosis (1 of 4)

MOST LIKELY/POSSIBLE CAUSES		SYMPTOMS																																							
		LOW/OSS OF POWER	HARD TO START	WILL NOT START	WILL NOT START-HOT	ENGINE STARTS-THEW COLD	ENGINE MISFIRES OR STALLS	ROUGH/ERRATIC IDLE	ENGINE WON'T SHUT OFF	POOR ACCELERATION	EXCESSIVE SPEED FLUCTUATES	EXCESSIVE WHITE SMOKE	BLACK SMOKE AT LOAD (NOT)	EXCESSIVE ACCELERATION AT IDLE	GREY SMOKE	BLUE SMOKE	EXCESSIVE LUBE OIL CONSUMPTION	EXCESSIVE FUEL CONSUMPTION	FUEL OR LUBE OIL CONSUMPTION	LUBE OIL COOLANT CONSUMPTION	COOLANT CONTAMINATED	HIGH COOLANT TEMPERATURE	NO TEXT FROM HEATER	CRANKCASE SLUDGE	LOW OIL PRESSURE	HIGH OIL PRESSURE	HIGH CRANKCASE PRESSURE	MECHANICAL KNOCKS	FUEL KNOCKS EXCESSIVE	SEIZED ENGINE COMPONENT	LOW CYLINDER COMPRESSION	ALL 10) GLOW PLUGS FAILED	RELAY WILL NOT CYCLE GLOW PLUGS	GLOW PLUG WILL NOT CYCLE GLOW PLUGS	WATER IN FUEL SYSTEM AND LIGHT MOTOR						
FUEL SYSTEM	PLUGGED, WAXED OR FAULTY FUEL FILTER(S)/ASSEMBLY	X	•	•	•	•				X	X	•	•	•			•		X																		•				
	FAULTY WATER FUEL(W/F) OR VACUUM SENSOR(S)																																				•				
	QUALITY/GRADE OR INCORRECT FUEL (GASOLINE)	•	•	X	X		•	•		•	•	X	X		X	X		•												•							•				
	AIR LEAKS IN FUEL SUCTION LINES	X	X	X	•	X	X	X	X	X	X	•																													
	RESTRICTED FUEL RETURN LINE	X	X	•	•	•		X		•	•	•			•			•																							
	FUEL TANK CAP NOT VENTED	•	•	•	•	•		•		•	•				•																										
	HIGH FUEL TEMPERATURE (ABOVE 90° F)	•						•		•	•																														
	FAULTY INJECTION PUMP OR SHAFT 180° OUT	•	•	•	•	•	•	•		•	•									•	•											•									
	FUEL INLET RESTRICTION HIGH AT SUPPLY PUMP	•	•	•	•	•	•			•	•																														
	FUEL PRESSURE BELOW (2) PSI AT INJECTION PUMP	•	•	•	•	•	•			•	•							•																							
	FAULTY FUEL SUPPLY PUMP (5 ½ PSI MIN.)	•	•	•	•	•	•			•										•	•																				
	NOZZLES, LINES OR HOSES	•	•				•	•		•	•	•	•	•				•		X										X	•										
	LOW IDLE RPM ADJUSTMENT			•		•	•	•				•																													
	FAST IDLE RPM ADJUSTMENT/FAULTY SOLENOID					•	•	•				•																													
	WATER/DEBRIS IN FUEL TANK OR FILTER(S)	•			•	•																										•					X				
	EXTERNAL FUEL LEAKS	•	•	•	•	•	•											•																							
	FAULTY ENGINE SHUT OFF SOLENOID (ESO)		•	•	•	•				X																															
	FAULTY INJECTION PUMP BALL CHECK REG. VALVE	•	•			•							•			•																									
	WORN OR STUCK INJECTION PUMP ADVANCE PISTON	X	•				•	•					•	•	•	•			•																						
	FAULTY INJECTION PUMP WEIGHT RETAINER RING	•				•	•	•																																	
	STICKING INTERNAL GOVERNOR LINKAGE/METERING VALVE	•				•		•	•																																
	INOPERATIVE FUEL LINE OR FILTER HEATER	•			•	•					•																														
	NO FUEL DELIVERY		•	•	•	•																																			
	INJECTION PUMP HOUSING PRESSURE (8-12 PSI)	•				•	•	•			•	•					•																	•	•						

X = LIKELIEST CAUSES
 • = POSSIBLE CAUSES

1. ENGINE OIL - NOTED
 2. FUEL-BLOW PLUGS O.K.
 3. WATER IN FUEL
 4. SYSTEM AND LIGHT INOP.
 5. LIGHT ON/BLINKS

ENGINE, DRIVEABILITY, AND DIAGNOSIS 6A-7

V3344

		MOST LIKELY/POSSIBLE CAUSES																																								SYMPTOMS			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40				
OPERATIONAL SYMPTOMS	GASKET BLOW-BY OR SEAL LEAKAGE	●								●		●				●		●	●			●	X	●		X					●				●	●									
	FAULTY DAMPER/FLYWHEEL BALANCE																																		X										
	VALVE LEAKAGE	●	●	●	●		●	●		●		●	●			●		●	●													●					X								
	BROKEN, SCORED OR WORN PISTONS/RINGS	●	●	●	●		●		●		●	●	●			●	●		●			●				●		●				●			●	●									
	INCORRECT MAIN OR ROD BEARING CLEARANCE																												●			●													
	DAMAGED CRANKSHAFT OR MAIN/ROD BEARINGS																																X		X										
	DAMAGED/WORN CAMSHAFT LOBES	●	●				●	●		●			●						●																●										
	FAULTY LIFTER OR GUIDE PLATE	●					●	●				●								●														●											
	FAULTY PUSHROD OR ROCKER ARM	●					●	●												●														●											
	WORN/MISALIGNED TIMING GEARS, CHAIN OR KEY(S)	●					●	●			●			●						●															●										
	LOW CYLINDER COMPRESSION (380 PSI MIN.)	●	●	X	●		●	●		●		●	●			●			●																●										
	OIL CHANGE INTERVAL																		●				●						X																
	EXTERNAL INJECTION PUMP THROTTLE LINKAGE	●						●		●																																			
	TIMING RETARDED	●	●		●		●	●		●		X				●				●																									
	TIMING ADVANCED	●	●		●		●	●					X	●	●					●															X					X					
	STARTER CRANKING SPEED/BATTERIES (180 RPM MIN.)		●	X	●																																			●					
	ENGINE MOUNTS/BOLTS OR FUEL LINE/OIL FILL TUBE CLAMPS																																												
	LONG IDLE PERIODS											●	●		●	●				●									●																
	CRACKED CYLINDER HEAD OR WALL												●								●															●	●								
	MISSING PRECHAMBER(S)	●					●	●					●	●																					●		●								
ENGINE OVERLOADED/EXCESSIVE SPEED	●								●			●		●				X	X									●																	
IMPROPER STARTING PROCEDURES		●		●																																									
DEBRIS/FLUID IN CYLINDER(S)																																													

X = LIKELIEST CAUSES

● = POSSIBLE CAUSES

SYMPTOMS

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		
E M I S S I O N S	INOPERATIVE GLOW PLUGS		●		X			●				●																															
	FAULTY GLOW PLUGS CONTROLLER/IP WIRE GROUNDS																																							X	●		X
	FAULTY GENERATOR DIODE/STARTER MOTOR WIRE CONNECTIONS																																							●		●	●
	INOPERATIVE GLOW PLUG CONTROLLER/RELAY		●			●																																		●		●	●
	SHORTED OR OPEN GLOW PLUG INHIBITOR SWITCH																																							X		X	X
	NO VOLTAGE TO CONTROLLER (KEY ON)																																									●	
	EGR VALVE STUCK OPEN		●											●		●				●																							
	EPR VALVE STUCK CLOSED		●											●		●				●																							
	FAULTY EGR/EPR SOLENOIDS, ECM, OR MAP SENSOR		●											●		●				●																							
	MISADJUSTED OR FAULTY THROTTLE POSITION SWITCH		●									●		●		●				●																							
	HOUSING PRESSURE COLD ADVANCE SOLENOID OR SWITCH					●	●		●			●	X							●																							
	FAULTY CRANKCASE DEPRESSION REGULATOR (CDR) VALVE																				●		●																●				
	CRANKCASE DEPRESSION SYSTEM HOSE CONNECTIONS																			X			X	●																	X		
	MISADJUSTED OR FAULTY VACUUM REGULATOR VALVE																				●																						
	TRANSMISSION CONVERTER DOES NOT APPLY																				●																						
FAULTY VACUUM PUMP (21" HG MIN.)											●		●	●	●				●																								
FAULTY ENGINE SPEED SENSOR		●									●		●	●	●	●			●																								
S Y S T E M		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		
	RESTRICTED AIR INTAKE DUCTING OR MANIFOLD	X	●			●				●			●	●																													

X = LIKELIEST CAUSES
● = POSSIBLE CAUSES

Figure 6—Diesel Engine Diagnosis (4 of 4)

DIAGNOSIS OF "SERVICE FUEL FILTER" LIGHT

PROBLEM	POSSIBLE CAUSE	CORRECTION
Intermittent Light	Water in fuel filter.	Drain water from the fuel filter.
Light Stays On With Engine Running (Temperature Above Freezing)	Fuel filter is clogged or contains water.	Drain the fuel filter. If no water is drained and the light stays on, replace the filter element.
Light Stays On With Engine Running (Temperature Below Freezing)	Fuel filter is clogged with ice.	Drain the fuel filter. If no water is drained, open the air bleed and check for fuel pressure. Replace the filter element if there is no pressure.
Light Comes On At High Speed Or During Heavy Acceleration	Plugged fuel filter.	Replace the filter element.
Light Stays On Continuously And Engine Stalls And Will Not Restart (After Initial Start-Up)	Fuel filter or lines plugged.	Replace the filter element or check the lines.
Light Stays On Continuously And Engine Stalls and Will Not Restart (After Refueling)	Large amounts of water pumped into the tank.	Purge the fuel tank.
D0250		

DIAGNOSIS OF NOISES

PROBLEM	POSSIBLE CAUSE	CORRECTION
High-Pitched Whine During Cranking (Before Engine Fires) But Engine Cranks And Fires Normally	Distance too great between starter pinion and flywheel.	Remove shims at the starter mount. Refer to SECTION 6D2.
High-Pitched Whine After The Engine Fires As Key Is Being Released. The Engine Cranks And Fires Normally. This Complaint Is Often Diagnosed As "Starter Hang-In" Or "Solenoid Weak".	Distance too small between starter pinion and flywheel. Flywheel runout contributes to the intermittent nature of the problem.	Add shims at the starter mount. Refer to SECTION 6D2.
A Loud "Whoop" After The Engine Fires But While The Starter Is Still Held Engaged. Sounds Like A Siren If The Engine Is Revved While The Starter Is Engaged.	Usually due to a worn starter motor clutch.	Remove the starter motor and check the starter clutch. Refer to the Light Duty Truck Unit Repair Manual.

DIAGNOSIS OF NOISES (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
A "Rumble", "Growl", Or (In Severe Cases) A "Knock" As The Starter Is Coasting Down To A Stop After Starting The Engine	Usually due to a bent or unbalanced starter armature.	Remove the starter motor and check the armature. Refer to the Light Duty Truck Unit Repair Manual.
Engine Noisy On Initial Start-Up But Only Lasts A Few Seconds	1. Hydraulic lifter bleed down. This condition is normal. Oil drains from the lifters, which are holding the valves open, when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started. 2. Improper oil viscosity.	1. None needed. 2. Install proper oil viscosity for expected temperatures. Refer to Owner's Manual.
Intermittently Noisy On Idle Only, Disappearing When Engine Speed Is Increased.	1. Dirt in hydraulic lifter. 2. Pitted or damaged lifter check ball.	1. Replace the hydraulic lifter. 2. Replace the hydraulic lifter.
Engine Knocks Cold And Continues For 2 To 3 Minutes. Knock Increases With Torque.	1. Flywheel contacting splash shield. 2. Loose or broken torsional damper or drive pulleys. 3. Excessive piston to bore clearance. 4. Bent connecting rod.	1. Reposition splash shield. 2. Tighten or replace as necessary. 3. Replace piston; inspect bore. 4. Replace connecting rod.
Noisy At Idle, Becoming Louder As Engine Speed Is Increased To 1500 RPM	1. This noise is not connected to hydraulic valve lifter malfunction. It becomes most noticeable in the vehicle at 10 to 15 mpg in "L" (Low) range, or 30 to 35 mph in "D" (Drive) range and is best described as a "ticking" sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following: • Badly worn or scuffed valve tip and rocker arm pad • Excessive valve stem to guide clearance. • Excessive valve seat runout. • Off-square valve spring. • Excessive valve face runout. • Valve spring damper clicking on rotor. 2. Off-square valve spring. Occasionally this noise can be eliminated by rotating the valve spring and valve. Crank engine until noisy valve is off its seat. Rotate spring. This will rotate valve. Repeat until valve is quiet. If correction is obtained, Check for off-square valve spring.	1. Repair as necessary. 2. If the valve spring is more than 1.6 mm (1/16 inch) off-square, it should be replaced.

DIAGNOSIS OF NOISES (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noisy At Slow Idle Or With Hot Oil; Quiet At Higher Engine Speeds Or with Cold Oil	High hydraulic lifter leak down rate.	Replace the hydraulic lifter.
Engine Knocks At Idle Hot	1. Loose or worn drive belts. 2. Air conditioning compressor or generator bearing. 3. Valve train. 4. Improper oil viscosity. 5. Excessive piston pin clearance. 6. Connecting rod alignment. 7. Insufficient piston to bore clearance. (Cold engine piston knock usually disappears when the cylinder's spark plug wire is grounded out. Cold engine piston knock which disappears in 1.5 minutes should be considered acceptable.) 8. Loose torsional damper.	1. Tension and/or replace as necessary. 2. Replace as necessary. 3. Refer to "Valve Train Noise" in this chart. 4. Install proper oil viscosity for expected temperatures. Refer to Owner's Manual. 5. Install new piston, pin and/or connecting rod as needed. 6. Check and replace rods as necessary. 7. Hone cylinder and fit new piston, if required. 8. Torque damper or replace worn parts.
Noisy At High Vehicle Speeds, Quiet At Low Speeds	1. High oil level—Oil level above the "Full" mark allows crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation. 2. Low oil level—Oil level below the "Add" mark allows the oil pump to pump air at high speeds, which results in noisy lifters. 3. Oil pan bent against oil pump pickup screen. 4. Oil pump pickup screen bent or loose.	1. Drain oil to proper level. 2. Add oil as needed. 3. Repair. 4. Repair.
Noisy Regardless Of Engine Speed	1. Incorrect valve adjustment (excessive lash) (engines with adjustable valve lash.) 2. Excessive valve lash. Check for valve lash by turning the engine so that the piston in that cylinder is on TDC of the firing stroke. If valve lash is present, the pushrod can be freely moved up and down a certain amount with the rocker arm held against the valve. Excessive lash can be caused by: A. Worn pushrod upper end ball. B. Bent pushrod. C. Improper lubrication of the pushrod. D. Loose or damaged rocker arm. E. If pushrod and rocker arm are OK, trouble in the hydraulic lifter is indicated.	1. Adjust as specified. 2. Repair engine as needed. A. Replace pushrod and rocker arm. B. Replace pushrod. C. Replace pushrod and rocker arm. Check lubrication system feed to the pushrod. D. Replace rocker arm. E. Replace hydraulic lifter.

DIAGNOSIS OF NOISES (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Has Light Knock Hot In Light Load Conditions	1. Faulty Ignition Control or Knock Sensor Circuit system. 2. Improper timing. 3. Poor quality fuel. 4. EGR valve malfunction. 5. Loose torque converter bolts. 6. Exhaust leak at manifold. 7. Excessive rod bearing clearance.	1. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 2. Adjust to specifications. 3. Use fuel of recommended grade. 4. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 5. Tighten bolts. 6. Tighten bolts and/or replace gaskets. 7. Replace bearings as necessary.
Engine Has Heavy Knock Hot With Torque Applied	1. Broken balancer or pulley hub. 2. Loose torque converter bolts. 3. Accessory belts too tight or nicked. 4. Exhaust system touching vehicle. 5. Flywheel cracked or loose flywheel rivets. 6. Excessive main bearing clearance. 7. Excessive rod bearing clearance.	1. Replace parts as necessary. 2. Tighten bolts. 3. Replace and/or tension to specs. as necessary. 4. Reposition as necessary. 5. Replace flywheel. 6. Repair as necessary. 7. Repair as necessary.
Valve Train Noise	1. Low oil pressure. 2. Loose rocker arm attachments. 3. Worn rocker arm and/or pushrod. 4. Broken valve spring. 5. Sticking valves. 6. Lifters worn, dirty, or faulty. 7. Camshaft worn or faulty. 8. Worn valve guides.	1. Repair as necessary. (See diagnosis for "Low Oil Pressure" in previous chart). 2. Inspect as necessary. 3. Replace as necessary. 4. Replace spring. 5. Free valves. 6. Refer to other hydraulic lifter-related causes and corrections in this chart. 7. Replace camshaft. 8. Repair as necessary.
Vibrating Or Rattling From Exhaust System	Loose and/or misaligned exhaust components.	Align, then tighten connections. Check for damaged hangers or mounting brackets and clamps.
Exhaust Leakage And/Or Noise	1. Leakage at exhaust component joints and couplings. 2. Improperly installed or misaligned exhaust system. 3. Exhaust manifold cracked or broken. 4. Leak between exhaust manifold or cylinder head. 5. Damaged or worn exhaust seals or packing. 6. Burned or rusted out exhaust pipe heat tube extension. 7. Burned or rusted out exhaust pipe. 8. Burned or blown out muffler. 9. Broken or loose exhaust clamps and/or brackets.	1. Tighten clamps or couplings to specified torque. 2. Align, then tighten connections. 3. Replace the manifold. 4. Tighten the manifold to cylinder head nuts and bolts to specifications. 5. Replace the seals or packings as necessary. 6. Replace the heat tube extensions as required. 7. Replace the exhaust pipe. 8. Replace the muffler assembly. 9. Repair or replace as necessary.

DIAGNOSIS OF POWER PROBLEMS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Hesitates During Normal Acceleration Hesitates During Cold Engine Operation	1. Engine control module malfunction. 2. Ignition timing misadjusted.	1. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 2. Adjust timing. Refer to Emission Control Information Label on vehicle.
Engine Has Less Than Normal Power At Normal Acceleration	1. Ignition system malfunction. 2. Ignition timing misadjusted. 3. Plugged air cleaner element. 4. Exhaust system restricted. 5. Engine control module malfunction. 6. Transmission malfunction. 7. Fuel filter(s) partially plugged. 8. Faulty fuel pump, or leaking or restricted fuel lines.	1. Check ignition system. Refer to SECTION 6D4. 2. Adjust timing. See Emission Control Information Label on vehicle. 3. Replace element. 4. Check for restrictions. See diagnosis for "Restricted Exhaust System" in this chart. 5. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 6. Refer to SECTION 7. 7. Inspect fuel filter(s). Replace as necessary. 8. Check fuel pump pressure and volume. Replace pump if necessary. Inspect fuel lines for leaks and restrictions.
Less Than Normal Power On Heavy Acceleration Or At High Speed	1. Ignition system malfunction. 2. Ignition timing misadjusted. 3. Plugged air cleaner element. 4. Exhaust system restricted. 5. Engine control module malfunction. 6. Transmission malfunction. 7. Fuel filter(s) partially plugged. 8. Faulty fuel pump or leaking or restricted fuel lines.	1. Check ignition system. Refer to SECTION 6D4. 2. Adjust timing. See Emission Control Information Label on vehicle. 3. Replace element. 4. Check for restrictions. Refer to diagnosis for "Restricted Exhaust System" in this chart. 5. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 6. Refer to SECTION 7. 7. Inspect fuel filter(s). Replace as necessary. 8. Check fuel pump pressure and volume. Replace fuel pump if necessary. Inspect fuel lines for leaks and restrictions.
Engine Surges	1. Ignition system malfunction. 2. Exhaust system restricted. 3. Engine Control Module malfunction. 4. Contaminated fuel. 5. Fuel filter(s) partially plugged. 6. Faulty fuel pump or leaking or restricted fuel lines.	1. Check ignition system. Refer to SECTION 6D4. 2. Check for restrictions. Correct as necessary. See diagnosis for "Restricted Exhaust System" in this chart. 3. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 4. Check for water or excessive alcohol in fuel. 5. Inspect fuel filter(s). Replace as necessary. 6. Check fuel pump pressure and volume. Replace pump if necessary. Inspect fuel lines for leaks and restrictions.

DIAGNOSIS OF POWER PROBLEMS (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Fuel Starvation	1. Fuel filter(s) plugged. 2. Fuel lines leaking, restricted or mis-routed. 3. Faulty fuel pump.	1. Inspect fuel filter(s). Replace as necessary. 2. Repair/replace, clean, or reroute as required. 3. Check fuel pump pressure and volume. Replace pump if necessary.
Restricted Exhaust System	1. Kinked exhaust tubing. 2. Restriction inside the muffler. 3. End of tail pipe obstruction. 4. Plugged three way catalytic converter (may result from serious engine malfunction).	1. If possible, repair the damaged condition, otherwise replace the component. 2. If restriction is suspected, remove the muffler and visually check it. Replace muffler if condition is doubtful. 3. Remove the obstruction, or if end is crimped, straighten outlet. 4. Replace the three way catalytic converter.

D0280

DIAGNOSIS OF STARTING/IDLING/SHUTOFF PROBLEMS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Will Not Turn Over	1. Battery, cranking system, or other electrical problem. 2. Liquid in combustion chamber. 3. Seized engine.	1. Refer to SECTION 6D2. 2. Remove with suction gun. 3. Repair.
Engine Cranks Normally—Will Not Start Or Starts Hard	1. Improper starting procedure used. 2. Ignition system malfunction. 3. Engine loaded with fuel. (Improper starting procedure used). 4. No fuel. 5. Restricted exhaust system. 6. Low compression due to stuck or burned valves, sticking piston rings, blown head gasket, etc. 7. Engine control module malfunction.	1. Check with the customer to determine if proper starting procedure, outlined in the Owner's Manual, is used. 2. Check ignition system. Refer to SECTION 6D4. 3. Check with the customer to determine if proper starting procedure, outlined in Owner's Manual, is used. 4. Inspect fuel filter(s) for plugging. Replace as necessary. Check fuel pump pressure and volume. Replace pump if necessary. Inspect fuel lines for leaks and restrictions. 5. Repair. Refer to the diagnosis for "Restricted Exhaust system" in "Power Problems" chart. 6. Perform a compression test, as outlined in this section. Repair engine as necessary. 7. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.

DIAGNOSIS OF STARTING/IDLING/SHUTOFF PROBLEMS (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Starts—Will Not Keep Running	1. Air leaks at intake manifold gasket. Vacuum hoses disconnected or installed improperly. 2. Not enough fuel. 3. Engine control module malfunction.	1. Use a pressure oil can to spray light oil or kerosene around manifold to head mounting surfaces. If engine rpm changes, torque intake manifold bolts to specification. If necessary, replace the intake manifold gasket(s). Check condition and routing of vacuum hoses. Correct or replace as necessary. Refer to Emission Control Information Label on vehicle for correct routing. 2. Inspect fuel filter(s) for being partially plugged. Replace as necessary. Check fuel pump pressure and volume. Replace pump if necessary. Inspect fuel lines for leaks and restrictions. 3. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
Engine Idles Abnormally (Too Fast Or Too Slow)	1. Engine control module malfunction. 2. Throttle linkage or throttle shaft sticking or binding. 3. Air leaks at intake manifold gasket, Vacuum hoses disconnected or improperly installed. 4. Restricted air cleaner element.	1. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 2. Check throttle linkage and throttle shaft(s) for smooth and free operation. Clean with suitable solvent. Replace throttle body if necessary. 3. Use a pressure oil can to spray light oil or kerosene around manifold to head mounting surfaces. If engine rpm changes, torque intake manifold bolts to specification. If necessary, replace the intake manifold gasket(s). Check condition and routing of vacuum hoses. Correct or replace as necessary. Refer to Emission Control Information Label on vehicle for correct routing. 4. Replace if necessary.
Rough Idle	1. Engine control module malfunction. 2. Uneven cylinder compression. 3. Bent pushrod or broken valve spring. 4. Faulty engine mount.	1. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 2. Perform a compression test, as outlined in this section. Repair engine as necessary. 3. Repair. 4. Repair or replace.

**DIAGNOSIS OF STARTING/IDLING/SHUTOFF
PROBLEMS (cont'd)**

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Diesels (After Run) Upon Shut Off	1. Air leaks at intake manifold gasket(s). Vacuum hoses disconnected or improperly installed. 2. PCV system malfunctioning. 3. Ignition timing retarded (causes throttle valve to be opened farther than normal to obtain correct idle speed). 4. Engine Control Module malfunction.	1. Use pressure oil can to spray light oil or kerosene around manifold to head mounting surfaces. If engine rpm changes, torque intake manifold bolts to specification. If necessary, replace the intake manifold gasket(s). Check condition and routing of vacuum hoses. Correct or replace as necessary. Refer to Emission Control Information Label for correct routing. 2. Check PCV system. Clean or replace PCV valves and hoses as necessary. 3. Adjust timing. See Emission Control Information Label. 4. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
D0281		

DIAGNOSIS OF POOR FUEL ECONOMY/SMOKE/OIL/ODORS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Poor Gas Mileage *Black Smoke From Tail Pipe	1. Customer driving habits. 2. Wrong speedometer gear. 3. Low tire pressure or incorrect tire size. 4. Transmission malfunction or in wrong gear. 5. Fuel leaks. 6. Plugged air cleaner element. 7. Ignition system malfunction. 8. Ignition timing misadjusted. 9. Engine control module malfunction. 10. Air leaks at intake manifold gasket. Vacuum hoses disconnected or improperly installed. 11. Engine in need of service 12. Restricted exhaust system.	1. Run mileage test, with customer driving if possible. Make sure engine has at least 2,000-3,000 miles (3,200-4,800 km) for the "break-in" period. 2. Check odometer against measured mile. Replace speedometer gear if necessary. Refer to SECTION 7. 3. Inflate tires to specifications and use correct tire sizes. Refer to label on driver's door. 4. Refer to SECTION 7. 5. Inspect fuel tank, fuel lines and fuel pump for any fuel leakage. 6. Replace element. 7. Check ignition system. Refer to SECTION 6D4. 8. Adjust timing. See Emission Control Information Label. 9. Check operation. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 10. Use a pressure oil can to spray light oil or kerosene around manifold to head mounting surfaces. If engine rpm changes, torque intake manifold bolts to specification. If necessary, replace the intake manifold gasket(s). Check condition and routing of vacuum hoses. Correct or replace as necessary. Refer to Emission Control Information Label on vehicle for correct routing. 11. Check engine compression. 12. Check for restrictions and correct as necessary.
Low Oil Pressure	1. Incorrect or faulty oil pressure switch or sensor. 2. Incorrect or faulty oil pressure gage. 3. Improper oil viscosity. 4. Diluted engine oil. 5. Oil pump worn or dirty. 6. Plugged oil filter. 7. Oil pickup screen loose or plugged. 8. Hole in oil pickup tube. 9. Excessive bearing clearance. 10. Cracked, porous or plugged oil galleries 11. Oil gallery plugs missing or mis-installed.	1. Replace with correct/new switch or sensor. 2. Replace with correct/new gage. 3. Replace with proper oil. Refer to Owner's Manual. 4. Change engine oil and filter. Repair cause of dilution (rich mixture, etc.). 5. Clean pump and replace worn parts as necessary. 6. Replace filter and oil. 7. Clean or replace screen as necessary. 8. Replace pickup tube. 9. Replace as necessary. 10. Repair or replace block. 11. Install plugs or repair as necessary.
Blue Smoke	Usually caused by oil burning in the combustion chambers.	Refer to the diagnosis for "Excessive Oil Loss" in this chart.

DIAGNOSIS OF POOR FUEL ECONOMY/SMOKE/OIL/ODORS (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
White Smoke	Usually caused by water vapor, which is a normal by-product of combustion. Usually seen on cold days.	None required.
Excessive Oil Loss	1. Improper reading of dipstick. 2. External oil leaks. 3. Improper oil viscosity. 4. Continuous high speed driving and/or severe usage. 5. Crankcase ventilation or PCV system malfunction. 6. Valve guides and/or valve stem seals worn, or seals missing. 7. Piston rings not seated. 8. Broken or worn piston rings. 9. Piston improperly installed.	1. Check oil with vehicle on a level surface and allow adequate drain down time. 2. Tighten bolts and/or replace gaskets and seals as necessary. 3. Use recommended viscosity for prevailing temperature. Refer to Owner's Manual. 4. Continuous high speed operation and/or severe usage will normally cause decreased oil mileage. 5. Check PCV system. Clean or replace PCV valves and hoses as necessary. 6. Ream guides and install oversize service valves and/or new valve stem seals. 7. Allow adequate time for rings to seat. 8. Replace broken or worn rings as necessary. 9. Replace piston or repair as necessary.
Gasoline Odor	1. Fuel feed, fuel return, or vapor return line leaking. 2. Leak in fuel tank. 3. Disconnected or leaking fuel tank vent lines or hoses to canister(s). 4. Purge lines not connected, improperly routed, plugged or pinched. 5. Evaporative Emission Control System carbon canister(s) loaded. 6. Faulty fuel tank fill cap.	1. Repair/replace as required. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 2. Purge tank and repair or replace tank as required. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 3. Connect, repair or replace lines as required. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 4. Connect, clean or reroute lines as required. Refer to Emission Control Information Label on vehicle for correct routing. 5. Compare weight of canister with a new one. Replace if necessary. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 6. Install new fuel filler cap. Be sure to use a cap designed for gasoline and evaporation systems.

D0282

DIAGNOSIS OF SPARK PLUGS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Brown to Grayish-Tan Deposits And Slight Electrode Wear.	Normal wear.	Clean, regap, reinstall.
Dry, Fluffy Black Carbon Deposits.	Poor ignition system output.	Check the distributor to coil connections, as discussed in SECTION 6D4 or refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
Wet, Oily Deposits With Very Little Electrode Wear.	1. "Break-in" of new or recently overhauled engine. 2. Excessive valve stem to guide clearance. 3. Worn intake valve seals.	1. Degrease, clean, and reinstall the plugs. 2. Refer to specific engine section for procedure. 3. Replace the seals.
Red, Brown, Yellow and White Colored Coatings on Insulator. Engine Misses Intermittently Under Severe Operating Conditions.	By-products of combustion.	Clean, regap, and reinstall. If heavily coated, replace.
Colored Coatings Heavily Deposited on the Portion of the Plug Projecting into the Chamber and on the Side Facing the Intake Valve.	Leaking seals if condition is found in only one or two cylinders.	Check the seals. Replace if necessary. Clean, regap, and reinstall the plugs.
D0283		

OIL LEAK DIAGNOSIS

Most oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedure may help in locating and repairing most leaks.

FINDING THE LEAK

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. From what point is the fluid leaking? After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper. After a few minutes, you should be able to find the approximate location of the leak by the drippings on the paper.
3. Visually check around the suspected component. Check around all gasket mating surfaces for leaks. Use a mirror for finding leaks that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam, or spray solvent. Clean, then dry the area. Operate the vehicle for several miles at normal

operating temperature and varying speeds. After operating the vehicle, visually check the suspected component. If you still cannot find the leak, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) on the suspected area.
3. Drive the vehicle under normal operating conditions.
4. Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

Black Light and Dye Method

A dye and light kit is available for finding leaks. Refer to the manufacturer's directions when using the kit.

1. Pour specified amount of dye into leaking component.
2. Drive the vehicle under normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

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REPAIRING THE LEAK

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must also be repaired. Before attempting to repair a leak, make sure the following conditions are correct as they may cause a leak.

Gasket Leaks

Check for:

- High fluid level or high oil pressure.
- Plugged ventilation filter or valve.
- Improperly tightened fasteners or dirty/damaged threads.

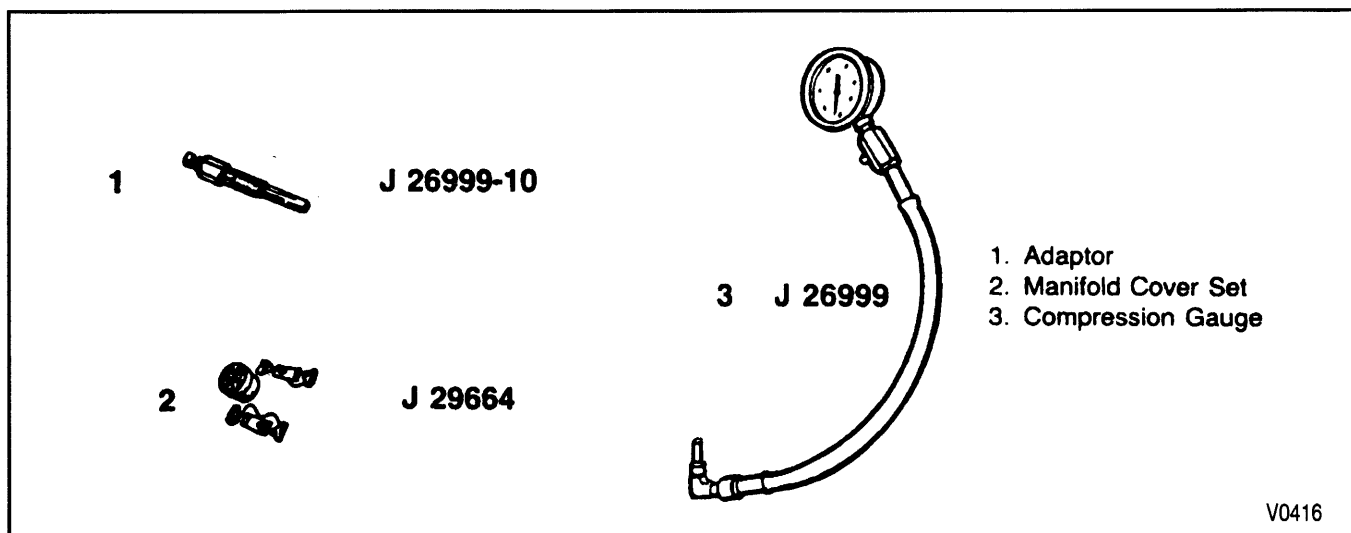
- Warped flanges or sealing surface.
- Scratches, burrs, or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant, or no sealant where required.

Seal Leaks

Check for:

- High fluid level or high oil pressure.
- Plugged ventilation filter, or valve.
- Damaged seal bore (scratched, burred, or nicked).
- Damaged or worn seal.
- Improper installation.
- Cracks in component.
- Shaft surface scratched, nicked, or damaged.
- Loose or worn bearing causing excess seal wear.

SPECIAL TOOLS



SECTION 6A3

4.3L V6

RPO LB4, VIN Z

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The 4.3L (262 CID) engines are 90-degree V6 type, overhead valve, liquid cooled, with cast iron block and cylinder heads.

The crankshaft is supported by four precision insert main bearings, with crankshaft thrust taken at the number four (rear) bearing.

The camshaft is supported by four plain type bearings and chain driven. Motion from the camshaft is transmitted to the valves by hydraulic lifters, pushrods, and ball type rocker arms. The valve guides are integral in the cylinder head on the light duty version and a non-serviceable press fit on the heavy duty version.

The connecting rods are forged steel, with precision insert type crankpin bearings. The piston pins are a press fit in the connecting rods and a floating fit in the piston.

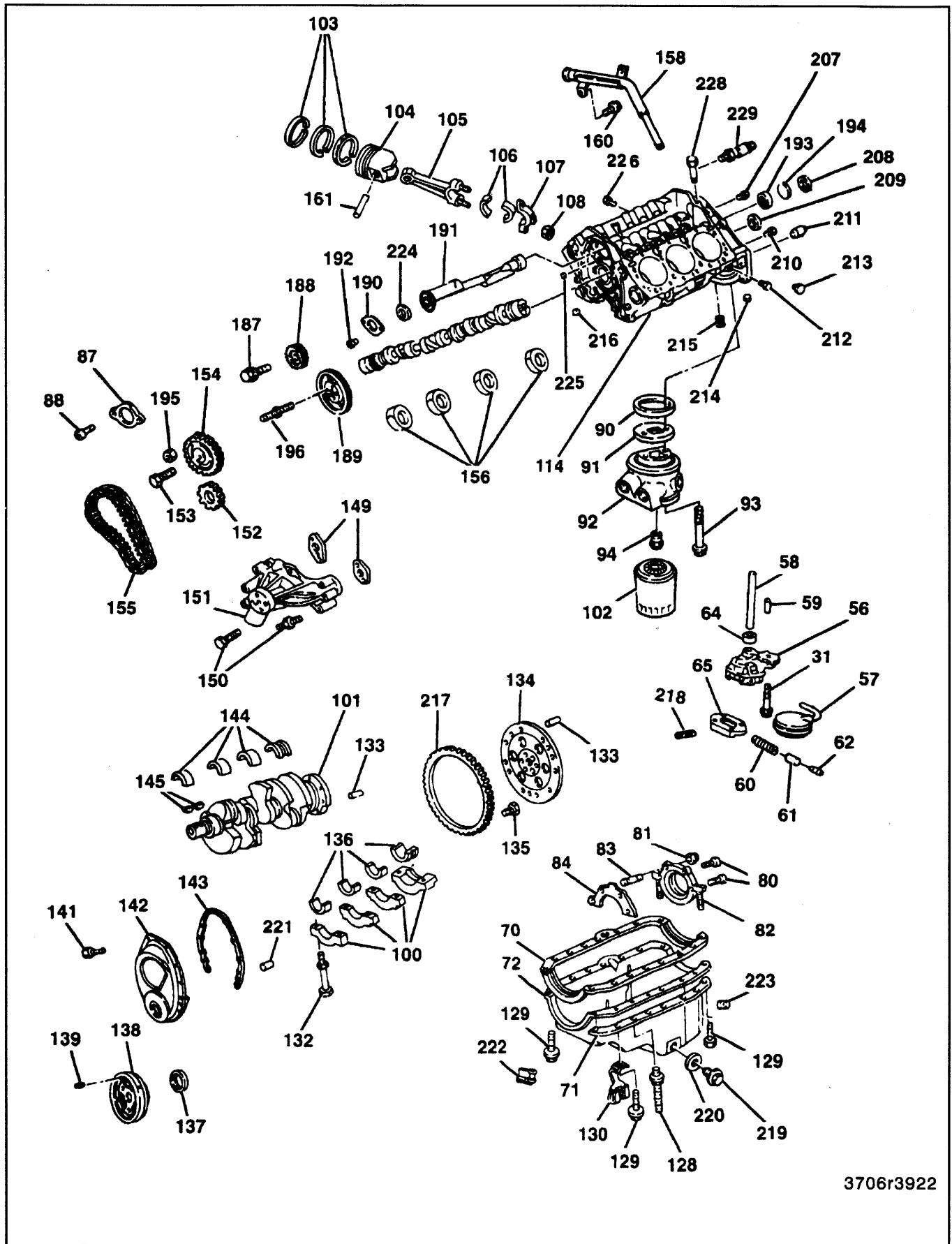
The pistons are cast aluminum alloy with a lower compression ratio on the heavy duty version.

For engine identification, refer to SECTION 0A. For engine component identification, refer to figures 1 through 4.

- | | |
|------------------------------------|--|
| 31. BOLT, OIL PUMP | 143. GASKET, FRONT COVER |
| 56. PUMP, OIL | 144. INSERT, UPPER MAIN BEARING |
| 57. SCREEN, OIL PUMP | 145. KEY, WOODRUFF |
| 58. SHAFT, OIL PUMP DRIVE | 148. CAMSHAFT |
| 59. PIN | 149. GASKET, COOLANT PUMP |
| 60. SPRING, OIL PRESSURE RELIEF | 150. BOLT/STUD, COOLANT PUMP |
| 61. VALVE, OIL PRESSURE REGULATOR | 151. PUMP, COOLANT |
| 62. PLUG | 152. SPROCKET, CRANKSHAFT |
| 64. RETAINER, OIL PUMP DRIVE SHAFT | 153. BOLT |
| 65. COVER, OIL PUMP | 154. SPROCKET, CAMSHAFT |
| 70. GASKET, OIL PAN | 155. CHAIN, TIMING |
| 71. REINFORCEMENT, OIL PAN | 156. BEARING, CAMSHAFT |
| 72. PAN, OIL | 158. TUBE, OIL LEVEL INDICATOR |
| 80. SCREW, SEAL RETAINER | 160. BOLT |
| 81. NUT, SEAL RETAINER | 161. PIN, PISTON |
| 82. RETAINER, SEAL | 187. BOLT, BALANCE SHAFT DRIVEN GEAR |
| 83. STUD, SEAL RETAINER | 188. GEAR, BALANCE SHAFT DRIVEN |
| 84. GASKET, SEAL RETAINER | 189. GEAR, BALANCE SHAFT DRIVE |
| 87. RETAINER, CAMSHAFT | 190. RETAINER, BALANCE SHAFT |
| 88. SCREW, CAMSHAFT RETAINER | 191. SHAFT, ENGINE BALANCE |
| 90. SEAL | 192. SCREW, BALANCE SHAFT RETAINER |
| 91. GASKET | 193. BEARING, BALANCE SHAFT REAR |
| 92. ADAPTER | 194. PLUG, CUP |
| 93. BOLT | 195. NUT, CAMSHAFT SPROCKET |
| 94. FITTING | 196. STUD, CAMSHAFT SPROCKET |
| 100. CAP, MAIN BEARING | 207. PLUG, HEX |
| 101. CRANKSHAFT | 208. SEAL, BALANCE SHAFT REAR BEARING PLUG |
| 102. FILTER, OIL | 209. PLUG, EXPANSION CUP |
| 103. RINGS, PISTON | 210. PLUG, SQUARE |
| 104. PISTON | 211. PIN, DOWEL |
| 105. ROD, CONNECTING | 212. PLUG, HEX |
| 106. BEARING, CONNECTING ROD | 213. PLUG, KNOCK SENSOR HOLE |
| 107. CAP, CONNECTING ROD BEARING | 214. PLUG, OIL PRESSURE |
| 108. NUT, CONNECTING ROD BOLT | 215. VALVE, OIL FILTER BYPASS |
| 114. BLOCK, ENGINE | 216. PLUG, OIL GALLERY |
| 128. STUD, OIL PAN | 217. GEAR, FLYWHEEL RING |
| 129. BOLT, OIL PAN | 218. PIN, OIL PRESSURE RELIEF VALVE SPRING |
| 130. CLIP | 219. PLUG, OIL PAN DRAIN |
| 132. BOLT, MAIN BEARING CAP | 220. GASKET, OIL PAN DRAIN PLUG |
| 133. PIN, GROOVE | 221. PIN |
| 134. FLYWHEEL | 222. NUT, HEX |
| 135. BOLT, FLYWHEEL | 223. NUT, HEX |
| 136. INSERT, LOWER MAIN BEARING | 224. BEARING, BALANCE SHAFT FRONT |
| 137. SEAL, CRANKSHAFT FRONT OIL | 225. PLUG, OIL PRESSURE |
| 138. DAMPER, CRANKSHAFT TORSIONAL | 226. PLUG, HEX |
| 139. PIN, GROOVE | 228. FITTING, OIL PRESSURE GAGE |
| 141. BOLT | 229. SENSOR, OIL PRESSURE GAGE |
| 142. COVER, FRONT | 230. SENSOR, KNOCK |

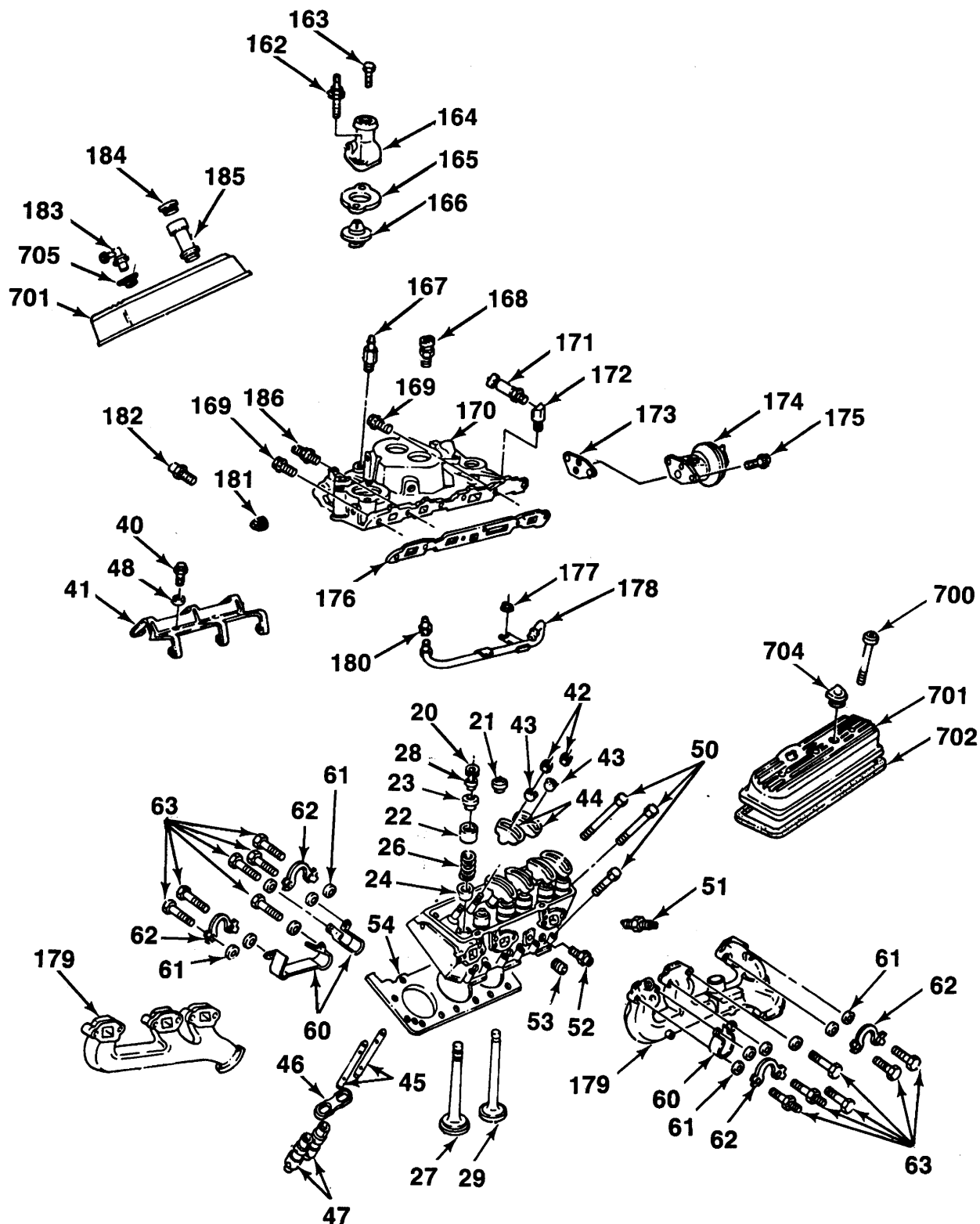
V3923

Figure 1—Cylinder Block and Components - Legend



3706r3922

Figure 2—Cylinder Block and Components



V1198

Figure 3—Cylinder Head, Manifolds, and Components

20. Valve Stem Key	163. Bolt	700. Rocker Arm Cover Bolt
21. Inlet Valve Spring Cap	164. Coolant Outlet	701. Rocker Arm Cover
22. Valve Stem Oil Shield	165. Coolant Outlet Gasket	702. Rocker Arm Cover Gasket
23. Valve Stem Oil Seal (O-Ring)	166. Thermostat	704. Crankcase Vent Tube Grommet
24. Inlet Valve Stem Seal	167. Vacuum Fitting	705. Crankcase Vent Valve Grommet
26. Valve Spring with Damper	168. Engine Coolant Temperature Sensor	
27. Inlet Valve	169. Bolt	
28. Exhaust Valve Rotator	170. Intake Manifold	
29. Exhaust Valve	171. Oil Pressure Sensor	
40. Lifter Restrictor Retainer Bolt	172. Oil Pressure Fitting	
41. Lifter Restrictor Retainer	173. E.G.R. Valve Gasket	
42. Rocker Arm Nut	174. E.G.R. Valve	
43. Rocker Arm Ball	175. Bolt	
44. Rocker Arm	176. Intake Manifold Gasket	
45. Push Rod	177. Nut	
46. Valve Lifter Guide (Restrictor)	178. Power Booster Vacuum Pipe	
47. Lifter	179. Exhaust Manifold	
48. Flat Washer	180. Power Booster Vacuum Pipe Fitting	
50. Cylinder Head Bolt	181. Plug	
51. Spark Plug	182. Coolant Temperature Sensor	
52. Coolant Temperature Sensor	183. Crankcase Ventilation Valve	
53. Drain Plug	184. Oil Filler Cap	
54. Cylinder Head Gasket	185. Oil Filler Tube	
60. Heat Shield	186. Bolt	
61. Washer		
62. Exhaust Manifold Lock		
63. Bolt/Stud		
162. Stud		

V1199

Figure 4—Cylinder Head, Manifolds, and Components - Legend

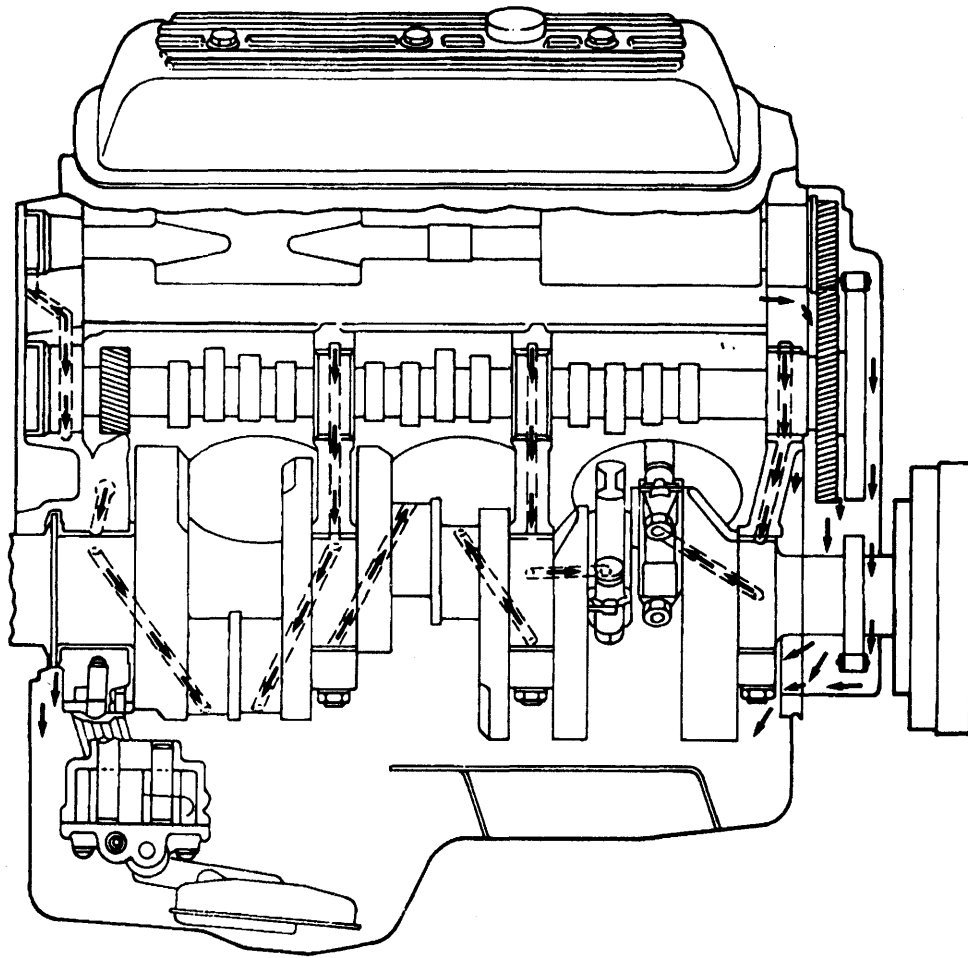
ENGINE LUBRICATION

Lubrication schematics are shown in figures 5 and 6. The gear type oil pump is driven from the distributor shaft, which is gear driven from the camshaft. Oil is drawn into the oil pump through a pickup screen and pipe.

Pressurized oil is routed to the oil filter. A bypass valve is provided to prevent excessive oil pressure. Filtered oil flows into the main gallery and then to the

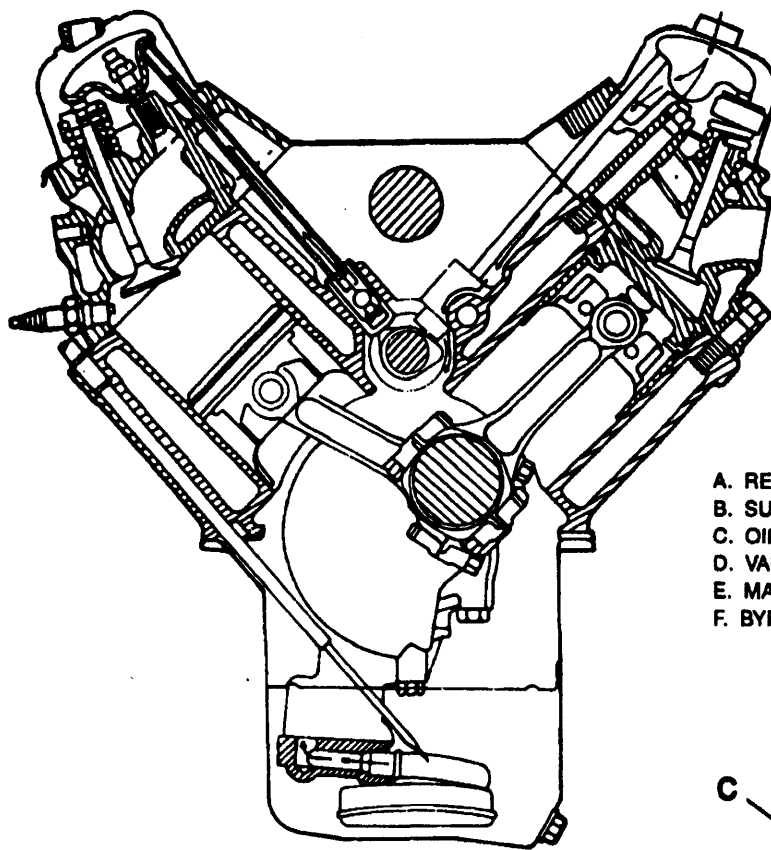
camshaft and crankshaft bearings. The valve lifter oil gallery supplies oil to the valve lifters. Oil flows from the hydraulic lifters through the hollow pushrods to the rocker arms. Oil from overhead drains back to the crankcase through oil drain holes.

The timing chain is drip fed from the front camshaft bearing. The pistons and piston pins are lubricated by oil splash.

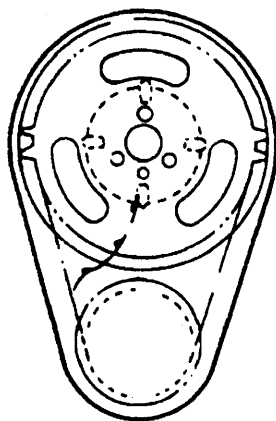


V0503

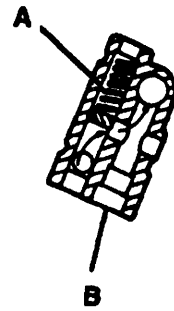
Figure 5—Engine Lubrication Diagram



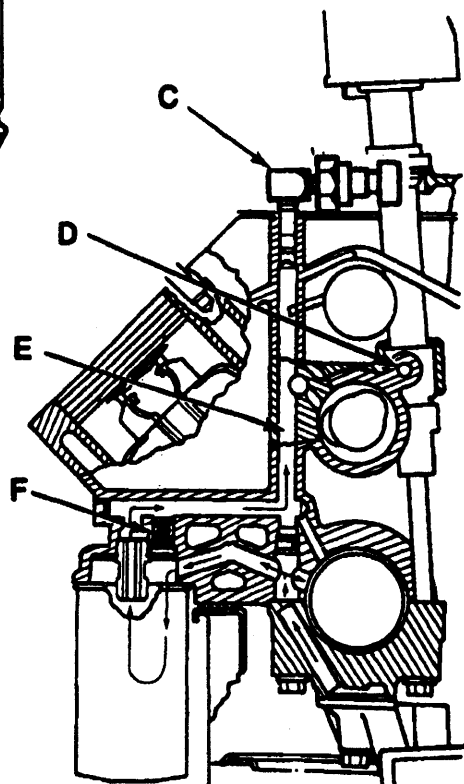
FRONT VIEW



FRONT VIEW
SHOWING PATH OF OIL TO TIMING CHAIN.



- A. REGULATOR VALVE (SHOWN IN OPEN POSITION)
- B. SUCTION
- C. OIL PRESSURE SWITCH
- D. VALVE LIFTER GALLERY
- E. MAIN OIL GALLERY
- F. BYPASS VALVE



REAR VIEW
SHOWING MAIN GALLERY, OIL FILTER AND CRANKSHAFT OIL FEED.

3106r5313

Figure 6—Engine Lubrication Diagram

ON-VEHICLE SERVICE

ROCKER ARM COVER REPLACEMENT

↔ Remove or Disconnect (Figure 7)

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
3. Wiring harnesses from the brackets and move aside.
4. Heat stove tube (right side cover).
5. Dipstick tube upper bracket at the cylinder head (right side cover).
6. Power brake vacuum pipe and move aside (left side cover).
7. Crankcase ventilation pipe or PCV valve at the cover.
8. Rocker arm cover bolts.
9. Rocker arm cover and gasket.

🧼 Clean

- All traces of the old gasket from the rocker arm cover and cylinder head.

🔍 Inspect

- Rocker arm cover sealing surface for distortion and damage. Replace if necessary.

↔ Install or Connect (Figure 7)

1. Rocker arm cover and gasket.

Notice: Refer to "Notice" on page 6A3-1.

2. Rocker arm cover bolts.

🔧 Tighten

- Rocker arm cover bolts to 10 N.m (90 lbs. in.).
3. Crankcase ventilation pipe or PCV valve.
 4. Power brake vacuum pipe (left side cover).
 5. Dipstick tube bracket (right side cover).
 6. Heat stove tube (right side cover).
 7. Wiring harnesses to the brackets.
 8. Air cleaner.
 9. Negative battery cable.

ROCKER ARM AND PUSHROD REPLACEMENT

↔ Remove or Disconnect

1. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
2. Rocker arm nut.
 - If only the pushrod is to be replaced, back the rocker arm nut off until the rocker arm can be swung away from the pushrod. Then pull the pushrod out.

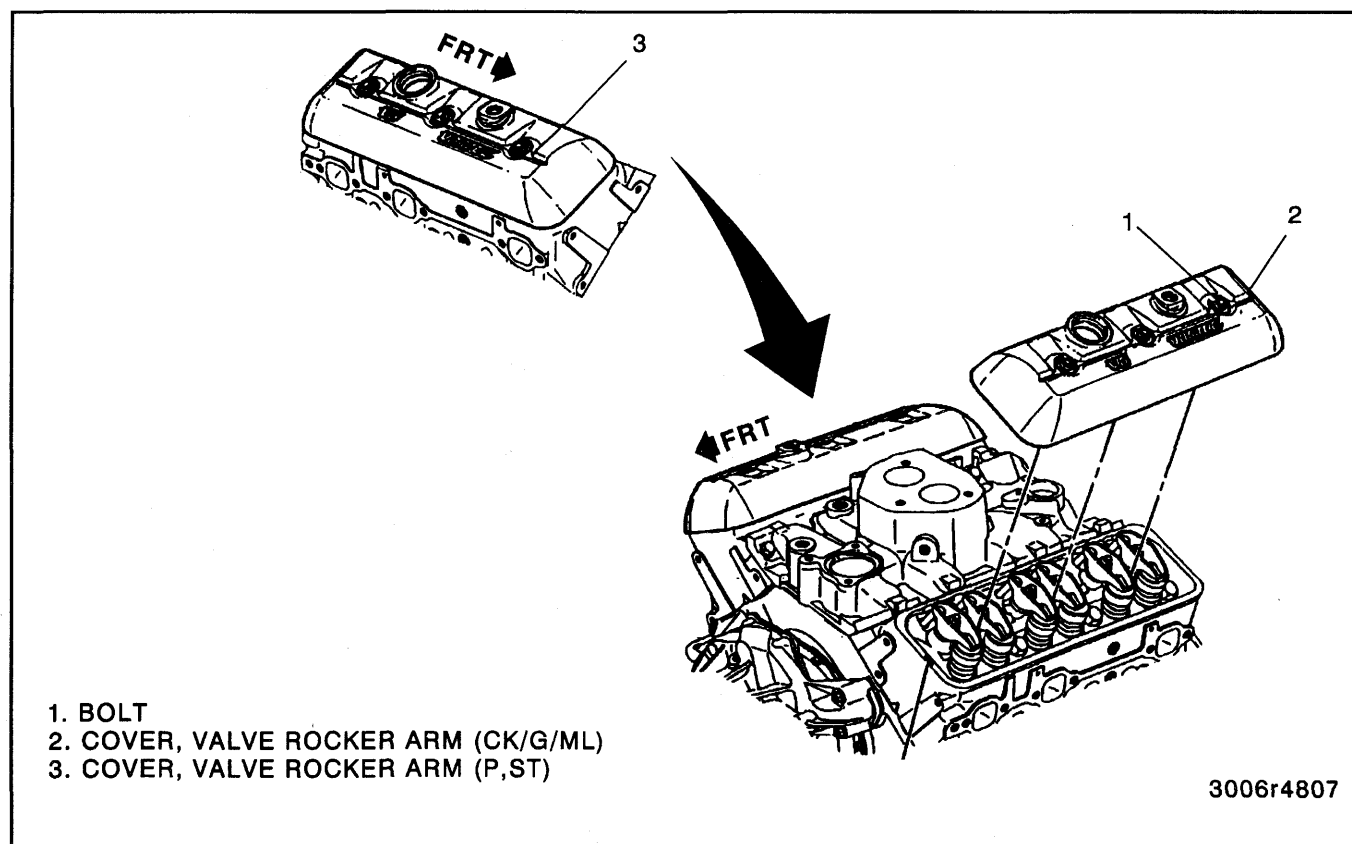


Figure 7—Rocker Arm Cover

3. Rocker arm with ball.
4. Pushrod.

! Important

- Store used components in an exact order, so they can be reassembled in the same position from which they were removed.

🔍 Inspect

- Rocker arms and balls at their mating surfaces. These surfaces should be free from wear or other damage.
- Rocker arm areas that contact the valve stems and the socket areas that contact the ends of the pushrods. These areas should be free of damage or wear.
- Pushrods for scoring, roughness, or bends.
 - Roll the pushrod on a flat surface to determine its straightness. If the rod is bent, the rod will not roll freely. Replace if necessary.

↔ Install or Connect

1. Pushrod. Make sure the pushrod seats properly in the hydraulic lifter.
2. Rocker arm with ball.

! Important

- When new rocker arms and/or balls are installed, coat their bearing surfaces with High Viscosity Oil with Zinc (GM P/N 12345501) or equivalent.

3. Rocker arm nuts.

🔧 Adjust (Figure 8)

- Valves, refer to "Valve Adjustment."
- 4. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."

VALVE ADJUSTMENT

1. Remove the rocker arm cover. Refer to "Rocker Arm Cover Replacement."
2. Turn the crankshaft, until the mark on the torsional damper lines up with the "O" mark on the timing tab and the engine in the number one firing position. This may be determined by placing fingers on the number one valve as the mark on the damper comes near the "O" mark on the timing tab. If the rocker arms are not moving, the engine is in the number one firing position. If the rocker arms move as the mark comes up to the timing tab, the engine is in the number four firing position. Turn the engine over one more time to reach the number one position.
3. With the engine in the number one firing position, as determined above, the following valves may be adjusted:
 - Exhaust: 1, 5, 6.
 - Intake: 1, 2, 3.

Even numbered cylinders are the right bank (passenger's side) and odd numbered cylinders are the left bank (driver's side).

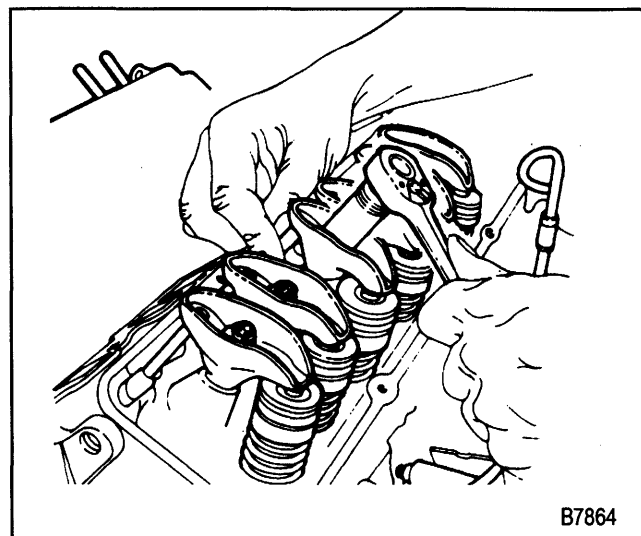


Figure 8—Adjusting the Valves

4. Back out the adjusting nut until lash is felt at the pushrod then turn in the adjusting nut until all lash is removed. This can be determined by rotating the pushrod while turning the adjusting nut (figure 8). When the play has been removed, turn the adjusting nut in 1 3/4 additional turns.
5. Crank the engine one revolution until the timing tab "O" mark and vibration damper mark are again in alignment. This is the number four firing position. The following valves may be adjusted:
 - Exhaust: 2, 3, 4.
 - Intake: 4, 5, 6.
6. Install the rocker arm cover as outlined previously.

VALVE STEM SEAL AND VALVE SPRING REPLACEMENT

↔ Install or Connect (Figures 9 and 10)

Tools Required:
 J 23590 Air Adapter
 J 5892-C Spring Compressor

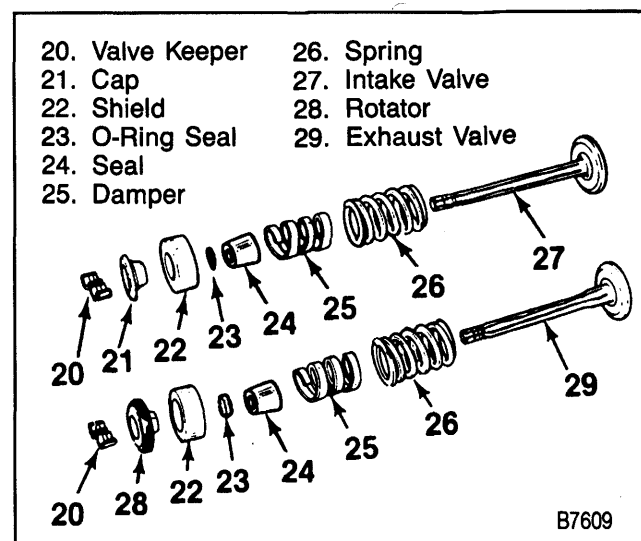


Figure 9—Valves and Components

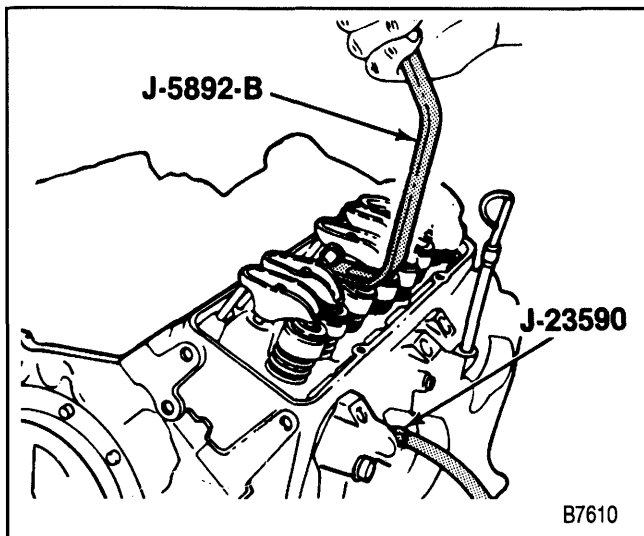


Figure 10—Compressing the Valve Springs

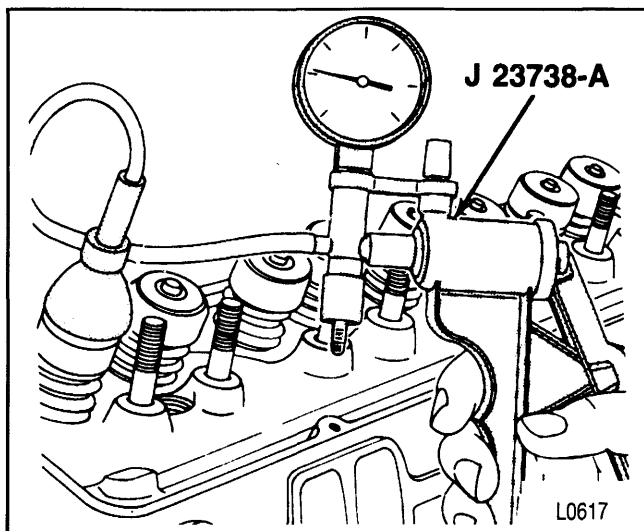


Figure 11—Checking the Valve Seals

1. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
2. Rocker arms. Refer to Rocker Arm and Pushrod Replacement."
3. Spark plugs. Refer to SECTION 6D4.
4. Valve keepers (20).
 - A. Install J 23590 into the spark plug hole.
 - B. Apply compressed air to hold the valves in place.
 - C. Install a rocker arm nut (figure 10)
 - D. Use J 5892-C to compress the valve spring (figure 10).
 - E. Remove the valve keepers.
 - F. Carefully release the spring tension. Remove J 5892-C.
5. Cap (21) and/or rotator (28), shield (22), and spring (26) with damper (25).
6. O-ring seal (23) and seal (24) (intake valve only).



Install or Connect (Figures 9, 10, and 11)

Tools Required:

- J 23590 Air Adapter
- J 5892-C Spring Compressor
- J 23738-A Vacuum Pump

1. New seal (24) (intake valve only). Install the seal over the intake valve stem and seat it against the head.
2. Spring (26) with damper (25), shield (22), and cap (21) and/or rotator (28).
3. New O-ring seal (23) and valve keepers (20).
 - A. With air pressure applied to the cylinder with J 23590, compress the spring with J 5892-C (figure 10).
 - B. Lubricate the O-ring seal with engine oil. Install the seal on the valve stem. Make sure the seal is not twisted.
 - C. Install the valve keepers. Use grease to hold them in place.
 - D. Carefully relieve spring pressure. Make sure the valve keepers stay in place.
 - E. Remove J 5892-C and J 23590.
 - F. Check each O-ring seal for leakage (figure 11).
 - a. Place the suction cup furnished with J 23738-A over the shield.
 - b. Connect J 23738-A to the suction cup and apply a vacuum. Watch the vacuum pump gage. No air should be able to leak past the seal. If the seal will not hold a vacuum, it may have been damaged or improperly installed.
4. Spark plugs. Refer to SECTION 6D4.
5. Rocker arms. Refer to "Rocker Arm Cover Replacement."



Adjust

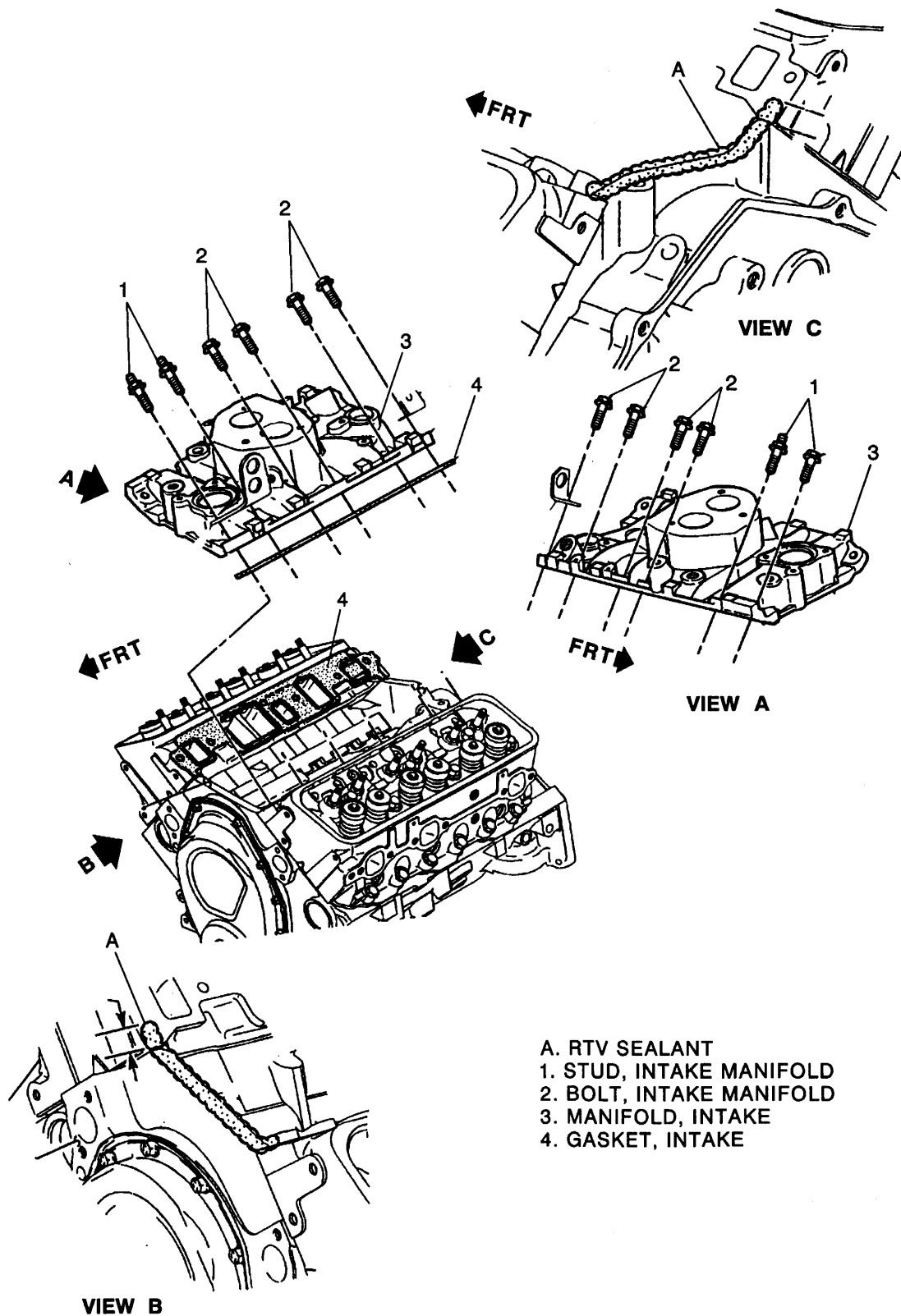
- Valves. Refer to "Valve Adjustment."
6. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."

INTAKE MANIFOLD REPLACEMENT



Remove or Disconnect (Figure 12)

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner and heat stove tube.
 - Drain the cooling system.
3. Distributor. Refer to SECTION 6D.
4. Accelerator and cruise control cables (if equipped) with bracket.
5. Air conditioning compressor rear bracket at the manifold.
6. Generator bracket at the manifold.
7. Idler pulley bracket at the manifold.
8. Fuel and vacuum lines and electrical connections at the TBI unit and manifold.
9. Heater pipe.
10. Upper radiator hose.
11. Power brake vacuum pipe.
12. Coil wires.



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Figure 12—Intake Manifold and Components

13. EGR vacuum line.
14. Sensors with bracket the on right side.
15. Wiring harnesses on the right side and move them out of the way.
16. Intake manifold bolts.
17. Intake manifold and gaskets.



Clean

- Old gasket and RTV from the block, heads, and intake manifold. Remove all RTV that is loose or will cause interference at assembly.
- Excessive carbon deposits from the exhaust and EGR passages.
- Excessive scale and deposits from the coolant passages.



Inspect

- Intake manifold for cracks and gasket surface damage.



Install or Connect (Figures 12 and 13)

1. Gaskets to the cylinder head.
2. RTV to the front and rear sealing surfaces on the block (figure 12). Apply a 5-mm (3/16-inch) bead of RTV (GM P/N 1052366) or equivalent to the front and rear of the block as shown. Extend the bead 13 mm (1/2 inch) up each cylinder head to seal and retain the gaskets.
3. Intake manifold to the engine.

Notice: Refer to "Notice" on page 6A3-1.

4. Intake manifold bolts.



Tighten

- Intake manifold bolts to 47 N·m (35 lbs. ft.) following the sequence shown in figure 13.
5. Wiring harness.
 6. Sensors with bracket.

7. EGR vacuum line.
8. Coil wires.
9. Power brake vacuum pipe.
10. Upper radiator hose.
11. Heater pipe.
12. Fuel and vacuum lines and electrical connections at the TBI unit and intake manifold.
13. Idler pulley bracket.
14. Generator bracket.
15. Air conditioning compressor rear brackets.
16. Accelerator and cruise control cables (if equipped) with bracket.
17. Distributor. Refer to SECTION 6D.
18. Air cleaner and heat stove tube.
19. Negative battery cable.

- Fill the cooling system with the proper coolant.

HYDRAULIC LIFTER REPLACEMENT



Remove or Disconnect (Figure 14)

1. Rocker arm cover, intake manifold, and pushrods. Refer to "Rocker Arm and Pushrod Replacement."
2. Bolts (40).
3. Retainer (41) with restrictors (46).
4. Hydraulic lifters.



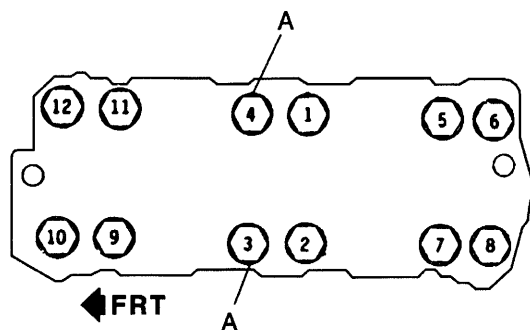
Important

- Remove the hydraulic lifters one at a time and place them in an organizer rack. The lifters must be installed in the same bore from which they were removed.



Inspect

- Hydraulic lifter body for scuffing or scoring. If the lifter body wall is worn or damaged, check the mating bore in the block.
- Check the fit of each hydraulic lifter in its mating bore in the block. If the clearance is excessive, try a new lifter.



A. SNUG THESE BOLTS TO 11 N·m (97 LBS. IN.), THEN TORQUE IN SEQUENCE TO 47 N·m (35 LBS. FT.)

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Figure 13—Intake Manifold Bolt Tightening Sequence

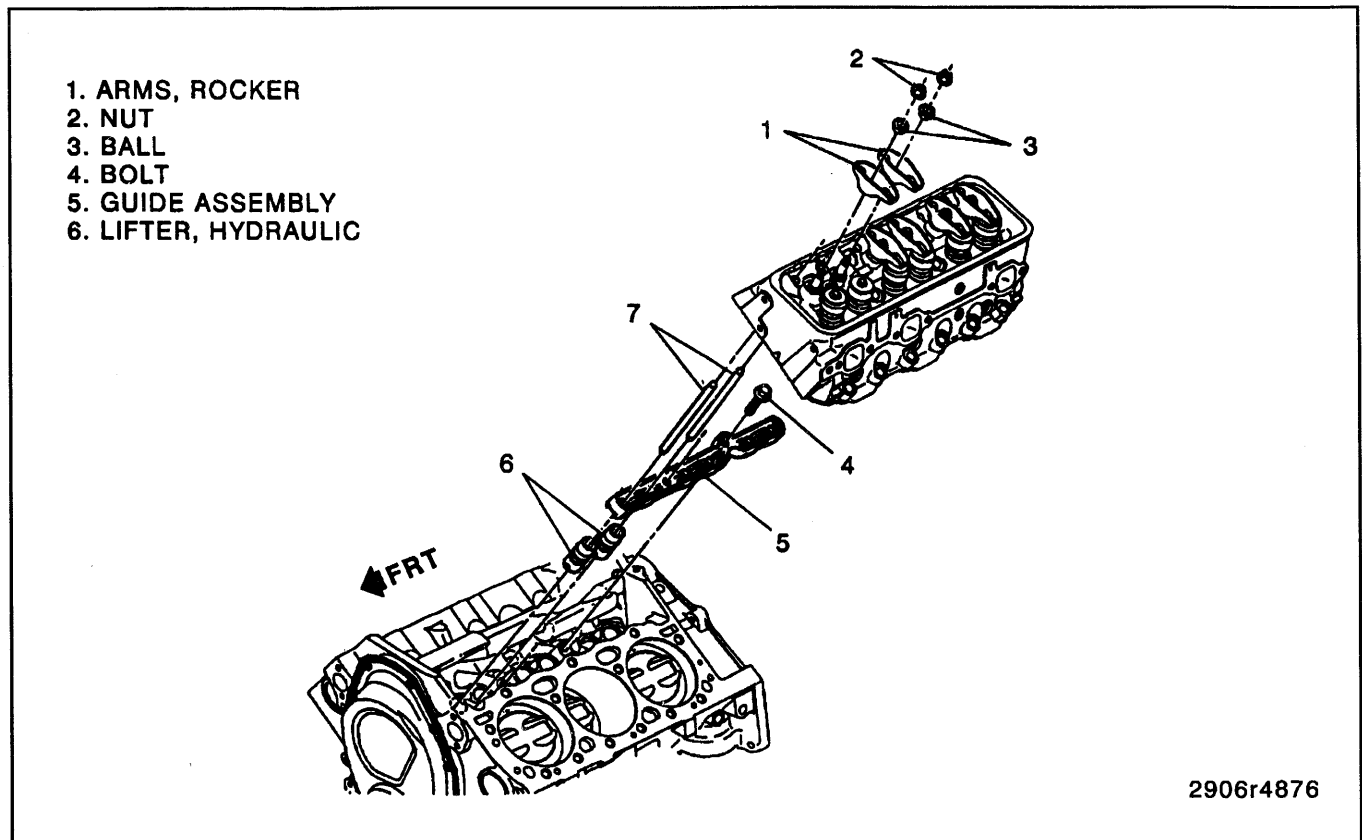


Figure 14—Valve Train Components

- Roller for freedom of movement.
- Roller for flat spots, pits, and missing or broken needle bearings. If worn, pitted, or damaged, check the mating camshaft lobe.

HYDRAULIC LIFTER REPAIR

- Refer to the Light Duty Truck Unit Repair Manual.

Install or Connect (Figure 14)

1. Hydraulic lifters in the block. Lubricate the lifter roller and body with High Viscosity Oil with Zinc (GM P/N 12345501) or equivalent.

Important

- When any new hydraulic lifters or a new camshaft is installed, change the engine oil and filter. Add engine oil supplement (GM P/N 1052367) or equivalent to the engine oil.
 - Replace all hydraulic lifters when a new camshaft is installed.
2. Retainer (41) with restrictors (46).

Notice: Refer to "Notice" on page 6A3-1.

3. Bolts (40).

Tighten

- Bolts (40) to 16 N·m (12 lbs. ft.).
4. Intake manifold. Refer to "Intake Manifold Replacement."

5. Pushrod. Refer to "Rocker Arm and Pushrod Replacement."

Adjust

- Valves. Refer to "Valve Adjustment."

6. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."

ROCKER ARM STUD REPLACEMENT

Remove or Disconnect (Figure 15)

Tool Required:

J 5802-01 Rocker Arm Stud Remover

1. Rocker arm cover and rocker arm. Refer to "Rocker Arm Cover Replacement" and "Rocker Arm and Pushrod Replacement."
2. Rocker arm stud.

- A. Place J 5802-01 over the rocker arm stud.
- B. Install a nut and flat washer.
- C. Turn the nut to remove the stud (figure 15).

Install or Connect (Figures 16 and 17)

Tools Required:

- J 5715 Reamer (0.003-inch oversize) or
- J 6036 Reamer (0.013-inch oversize)
- J 6880 Rocker Arm Stud Installer

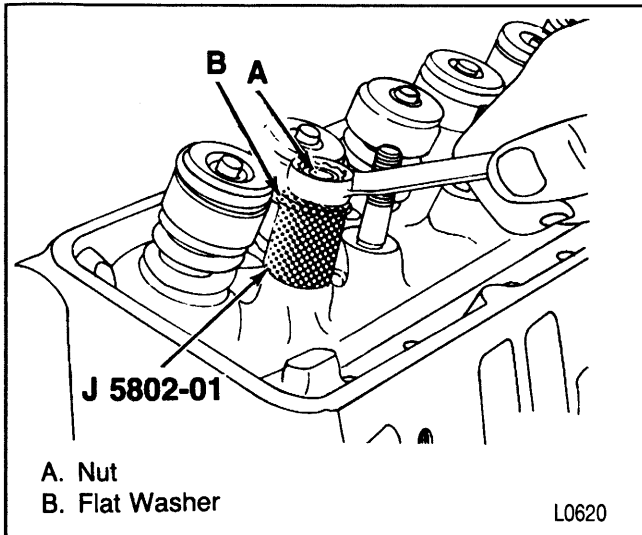


Figure 15—Removing the Rocker Arm Stud

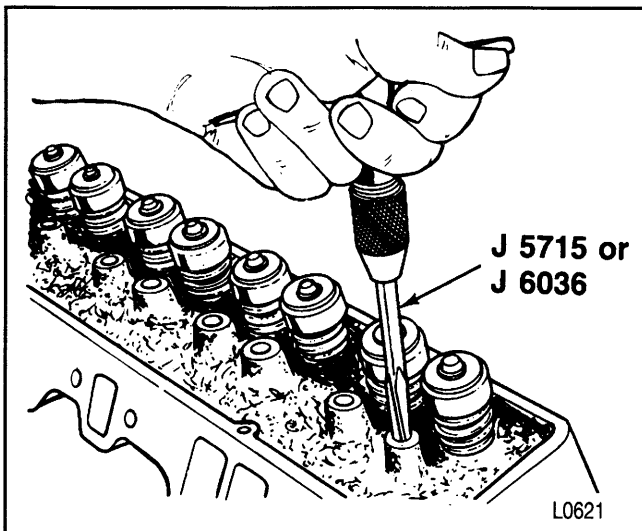


Figure 16—Reaming the Rocker Arm Stud Bore

NOTICE: Do not attempt to install an oversize rocker arm stud without reaming the stud hole as this could damage the cylinder head.

- Ream the hole to the proper size for the replacement oversize rocker arm stud. Use J 5715 for 0.003-inch oversize studs; J 6036 for 0.013-inch oversize stud (figure 16).
- Coat the lower end (press-fit area) of the rocker arm stud with axle lubricant.

1. Rocker arm stud. Use J 6880 (figure 17). Stud is installed to proper depth when the tool bottoms on the cylinder head.
2. Rocker arm. Refer to "Rocker Arm and Pushrod Replacement."



Adjust

- Valves. Refer to "Valve Adjustment."
3. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."

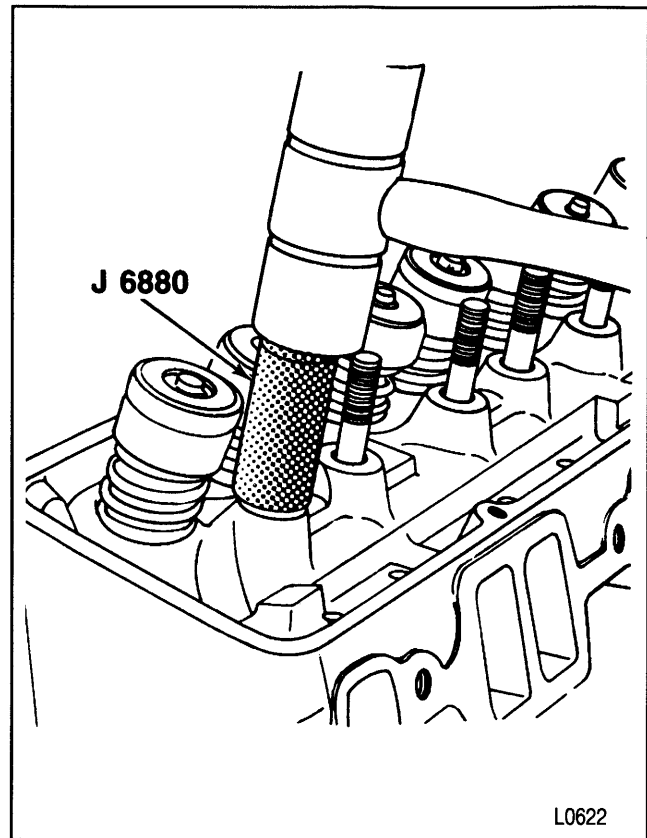


Figure 17—Installing the Rocker Arm Stud

EXHAUST MANIFOLD REPLACEMENT



Remove or Disconnect (Figure 18)

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle and support with safety stands.
2. Exhaust pipe at the manifold.
 - Lower the vehicle.
3. Oxygen sensor wire (left side manifold). Do not remove the oxygen sensor from the manifold unless it is to be replaced.
4. Power steering pump bracket at the manifold (left side manifold).
5. Heat stove pipe (right side manifold).
6. AIR hose at the check valve.
7. Exhaust manifold bolts, washers, heat shield, and tab washers.
8. Exhaust manifold.



Clean

- Mating surfaces on the exhaust manifold and head.
- Threads on the exhaust manifold bolts.



Install or Connect (Figure 18)

Notice: Refer to "Notice" on page 6A3-1.

1. Exhaust manifold, bolts, washers, heat shield (left side manifold), and tab washers.

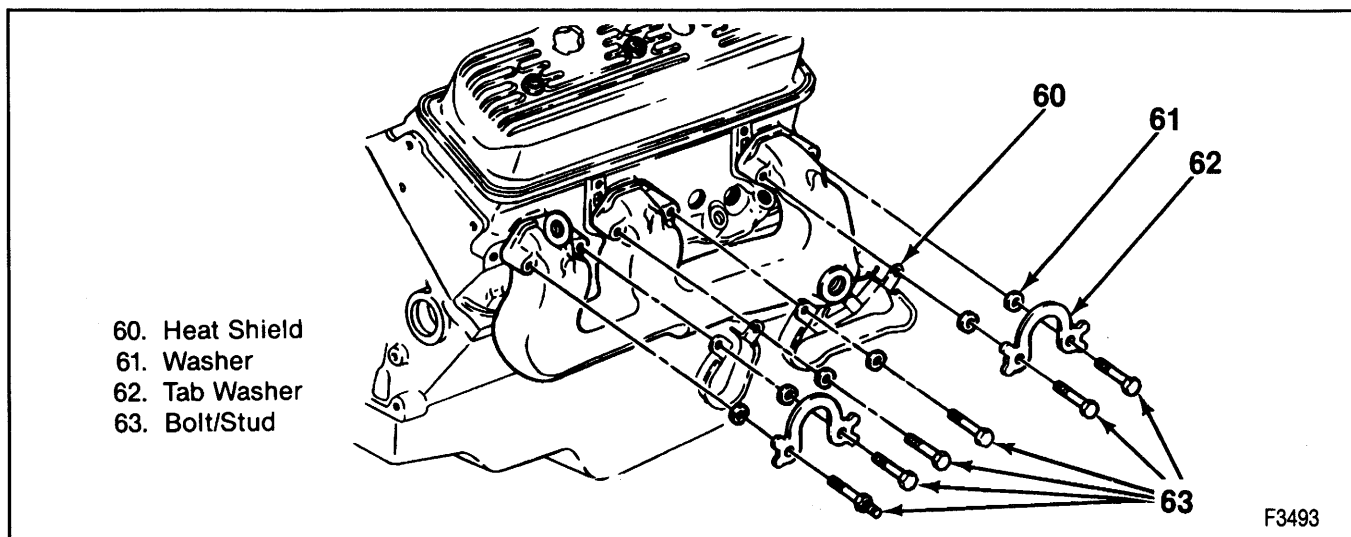


Figure 18—Exhaust Manifold and Components



Tighten

- A. Bolts on center exhaust tube to 36 N.m (26 lbs. ft.).
- B. Bolts on front and rear exhaust tubes to 28 N.m (20 lbs. ft.).
- C. Bend the tab washers over the heads of all bolts.
2. AIR hose at the check valve.
3. Heat stove tube (right side manifold).
4. Power steering pump bracket at the manifold.
5. Oxygen sensor wire (left side manifold).
 - Raise the vehicle and support with safety stands.
6. Exhaust pipe to the manifold.
 - Lower the vehicle.
7. Negative battery cable.

CYLINDER HEAD REPLACEMENT



Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
2. Intake manifold. Refer to "Intake Manifold Replacement."

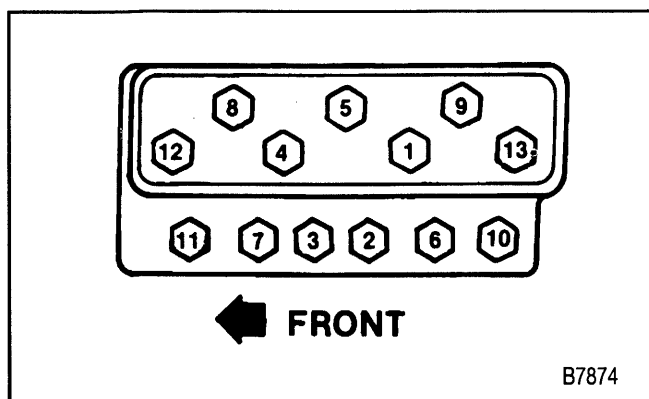


Figure 19—Cylinder Head Bolt Tightening Sequence

3. Exhaust manifold. Refer to "Exhaust manifold Replacement."
4. AIR pipe at the rear of the head.
5. AIR pump mounting bolt and spacer at the cylinder head (right cylinder head).
6. Engine accessory bracket bolts and studs at the cylinder head. For left cylinder head removal, it may be necessary to loosen the remaining bracket bolts to provide clearance for head removal.
7. Spark plug wires at the brackets.
8. Ground strap (right cylinder head).
9. Coolant sensor wire (left cylinder head).
10. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
11. Spark plugs. Refer to SECTION 6D4.
12. Pushrods. Refer to "Rocker Arm and Pushrod Replacement."
13. Cylinder head bolts.
14. Cylinder head.
15. Gasket.



Clean

- Carbon deposits from combustion chambers.
- All traces of old head gasket from the cylinder head and block.
- Cylinder head bolt threads and threads in the block.



Inspect

- Sealing surfaces of the block and cylinder head for nicks, heavy scratches, or other damage.

CYLINDER HEAD REPAIR

- Refer to the Light Duty Truck Unit Repair Manual.



Install or Connect (Figure 19)

1. Head gasket.
 - Do not use sealer on composition gaskets.
 - Place the gasket over the block dowel pins.

2. Cylinder head. Carefully guide the cylinder head into place over the dowel pins and gasket.

Notice: Refer to "Notice" on page 6A3-1.

3. Cylinder head bolts. Coat threads of the cylinder head bolts with sealing compound (GM P/N 1052080) or equivalent and install finger-tight.



Tighten

- Cylinder head bolts in three steps using the sequence shown in figure 19.
 - A. The first sequence to 34 N.m (25 lbs. ft.).
 - B. The second sequence to 61 N.m (45 lbs. ft.).
 - C. The final sequence to 90 N.m (65 lbs. ft.).
- 4. Pushrods. Refer to "Rocker Arm and Pushrod Replacement."



Adjust

- Valves. Refer to "Valve Adjustment."
5. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
 6. Spark plugs. Refer to SECTION 6D4.
 7. Coolant sensor wire (left cylinder head).
 8. Ground strap (right cylinder head).
 9. Spark plug wires. Refer to SECTION 6D4.
 10. Engine accessory bracket bolts and studs.
 11. AIR pump mounting bolt and spacer (right cylinder head).
 12. AIR pipe.
 13. Exhaust manifold. Refer to "Exhaust Manifold Replacement."
 14. Intake manifold. Refer to "Intake Manifold Replacement."
 15. Negative battery cable.

TORSIONAL DAMPER AND CRANKSHAFT FRONT SEAL REPLACEMENT



Remove or Disconnect (Figure 20)

Tool Required:

- J 39046 Torsional Damper Puller and Installer
1. Multiple ribbed belt, fan, and pulley. Refer to SECTION 6B1.
 2. Fan shroud assembly. Refer to SECTION 6B2.
 3. Accessory drive pulley. Refer to SECTION 6B1.
 4. Torsional damper bolt.

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber type material. The correct removal procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the torsional damper.

5. Torsional damper. Use J 39046 (figure 20).
6. Crankshaft front seal. Pry out with a large screwdriver.
 - Do not to distort the timing cover.

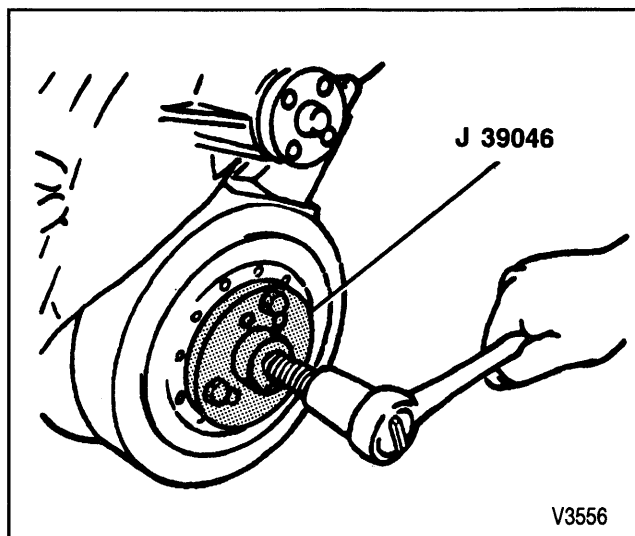


Figure 20—Removing the Torsional Damper

7. Crankshaft key, if necessary.



Inspect

- Oil seal contact area on the torsional damper shaft for grooving and roughness. Replace if necessary.



Install or Connect (Figures 21 and 22)

Tools Required:

- J 35468 Seal Installer
 - J 39046 Torsional Damper Puller and Installer
1. Crankshaft key, if removed.
 2. Crankshaft front seal. Use J 35468 (figure 21). The open end of the seal faces inside the engine. Coat the seal lips with engine oil.

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the torsional damper.

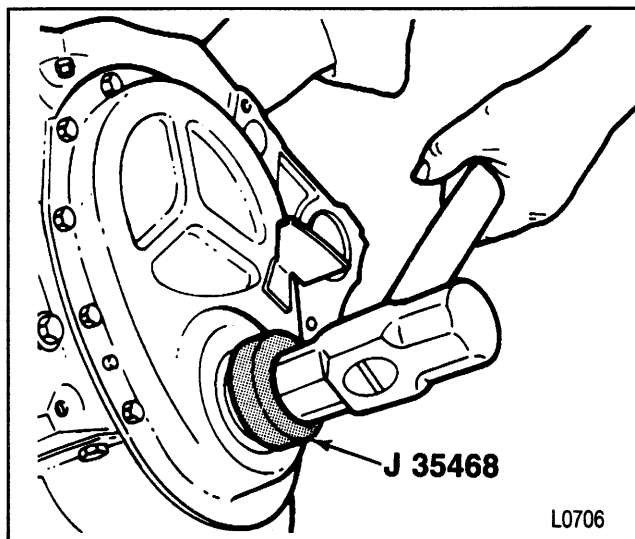


Figure 21—Installing the Crankshaft Front Seal

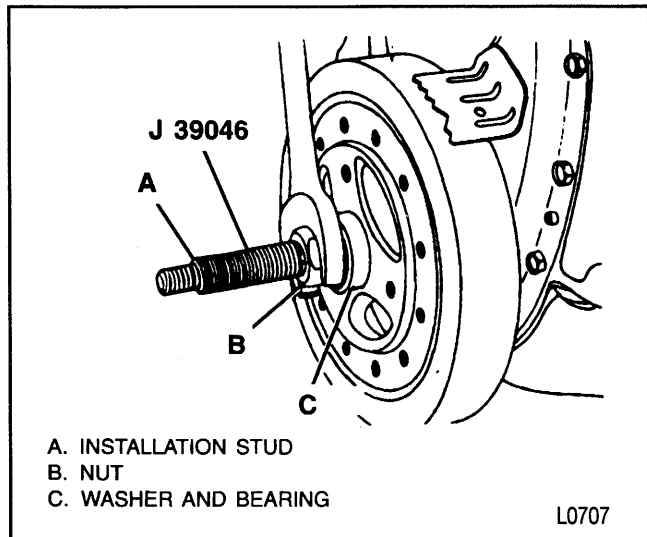


Figure 22—Installing the Torsional Damper

3. Stud (item A, figure 22) to the crankshaft. Thread the stud fully into the tapped hole in the crankshaft.
4. Torsional damper over the end of the stud. Align the keyway in the torsional damper shaft with the crankshaft key.

- Use a small amount of RTV sealant to seal the torsional damper key to crankshaft joint.

5. Bearing, washer, and nut (figure 22).

- A. Turn the nut to pull the vibration damper into place.
- B. Remove the tool.

Notice: Refer to "Notice" on page 6A3-1.

6. Torsional damper bolt and washer.



Tighten

- Bolt to 95 N.m (70 lbs. ft.).

7. Accessory drive pulley. Refer to SECTION 6B1.
8. Fan shroud assembly. Refer to SECTION 6B2.
9. Fan pulley, fan, and multiple ribbed belt. Refer to SECTION 6B1.

FRONT COVER REPLACEMENT



Remove or Disconnect

1. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."
2. Coolant pump. Refer to SECTION 6B1.
3. Oil pan. Refer to "Oil Pan Replacement."
4. Front cover bolts.
5. Front cover.
6. Front cover to block gasket.
7. Crankshaft front oil seal from the front cover. Pry out with a screwdriver. Take care not to distort the front cover.



Clean

- Old gasket from the front cover and block.



Inspect

- Front cover for distortion and damage. Replace if necessary.



Install or Connect (Figure 23)

Tool Required:

J 35468 Seal Installer

1. Crankshaft front oil seal. Use J 35468 (figure 23). The open end of the seal faces inside the engine. Coat the seal lips with engine oil.
2. Front cover gasket to the front cover. Use gasket cement to hold them in place.
3. Front cover and bolts.

Notice: Refer to "Notice" on page 6A3-1.



Tighten

- Front cover bolts to 14 N.m (124 lbs. in.).
4. Oil pan. Refer to "Oil Pan Replacement."
 5. Coolant pump. Refer to SECTION 6B1.
 6. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."

OIL PAN REPLACEMENT

A one-piece type oil pan gasket is used.



Remove or Disconnect (Figure 24)

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle and support with safety stands.
 - Drain the engine oil.
2. Exhaust crossover pipe.
3. Torque converter cover (models with automatic transmission).
4. Strut rods at flywheel cover (if used). Refer to SECTION 7C.
5. Strut rods at the front engine mountings (if used).
6. Starter motor. Refer to SECTION 6D2.

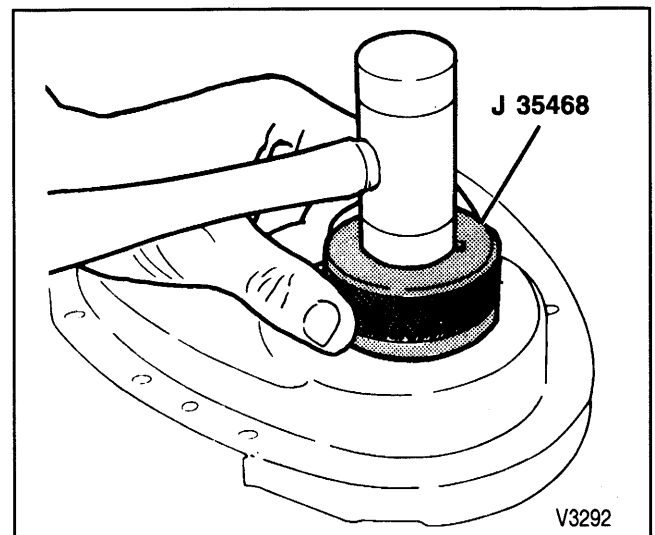


Figure 23—Installing the Crankshaft Front Seal

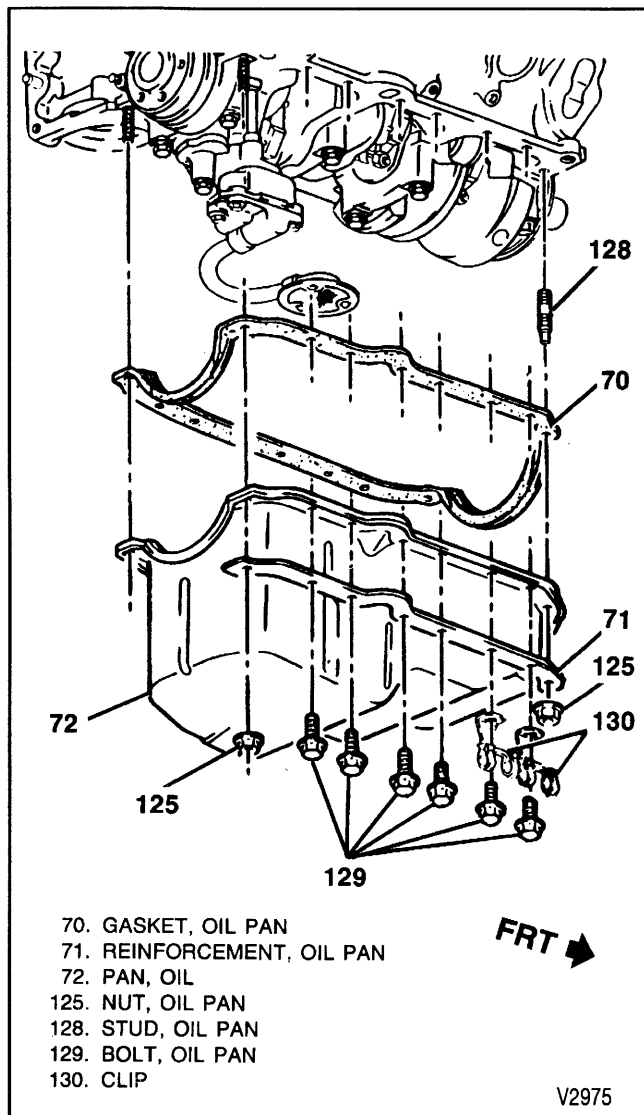


Figure 24—Oil Pan and Components

7. Strut rods at engine mounts (if used). Refer to SECTION 7C.
8. Oil pan bolts, nuts, and reinforcements.
9. Oil pan and gasket.



Clean

- Gasket surfaces on the engine and oil pan.



Inspect

- Oil pan gasket for damage. Replace if necessary.



Install or Connect (Figure 24)

- Apply sealant (GM P/N 1052080) or equivalent to the front cover to block joint and to the rear crankshaft seal to block joint. Apply the sealant for about 25 mm (1 inch) in both directions from each of the four corners.
1. Oil pan gasket to the oil pan.
 2. Oil pan to the engine.

Notice: Refer to "Notice" on page 6A3-1.

3. Oil pan bolts, nuts, and reinforcements.



Tighten

- Oil pan bolts to 11 N.m (100 lbs. in.).
 - Oil pan nuts at corners to 23 N.m (17 lbs. ft.).
4. Strut rods at the engine mounts (if used). Refer to "Engine Replacement."
 5. Starter motor. Refer to SECTION 6D2.
 6. Strut rod brackets at the front engine mountings (if used). Refer to "Engine Replacement."
 7. Strut rods at the flywheel cover (if used). Refer to SECTION 7C.
 8. Converter cover (models with automatic transmission).
 9. Exhaust crossover pipe.
 - Lower the vehicle.
 10. Proper quantity and grade of engine oil. Refer to SECTION 0B.
 11. Negative battery cable.

OIL PUMP REPLACEMENT



Remove or Disconnect

1. Oil pan. Refer to "Oil Pan Replacement."
2. Oil pump to main bearing cap bolt.
3. Oil pump.



Inspect

- Oil pump pickup tube for looseness. If the tube is loose in the oil pump body, replace it, as outlined in the Light Duty Truck Unit Repair Manual. A loose pickup tube can result in an air leak and loss of oil pressure.

OIL PUMP REPAIR

- Refer to the Light Duty Truck Unit Repair Manual.



Install or Connect

1. Oil pump to the engine. Align the slot in the oil pump shaft with the tang on the distributor shaft. The oil pump should slide easily into place. No gasket is used.

Notice: Refer to "Notice" on page 6A3-1.

2. Oil pump to main bearing cap bolt.



Tighten

- Oil pump to main bearing cap bolt to 90 N.m (65 lbs. ft.).
3. Oil pan. Refer to "Oil Pan Replacement."

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Remove or Disconnect (Figure 25)

1. Transmission. Refer to SECTION 7.
2. Clutch and flywheel or flexplate, as equipped. Refer to SECTION 7C.

NOTICE: Use care when removing the rear crankshaft oil seal so as not to nick the crankshaft sealing surface.

3. Crankshaft rear oil seal. Insert a screwdriver into the notches provided in the seal retainer and pry the seal out (figure 25). Do not damage the crankshaft sealing surface.

Inspect

- Chamfer on crankshaft for grit, loose rust, and burrs. Correct as necessary.

Clean

- Seal running surface on the crankshaft with a non-abrasive cleaner.

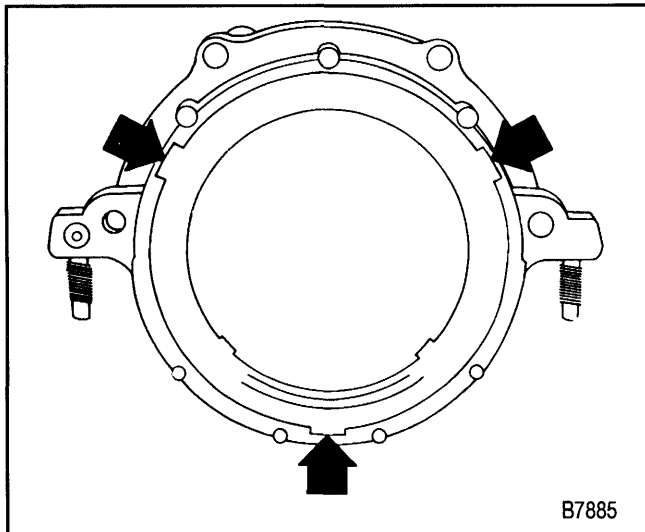


Figure 25—Seal Removal Notches

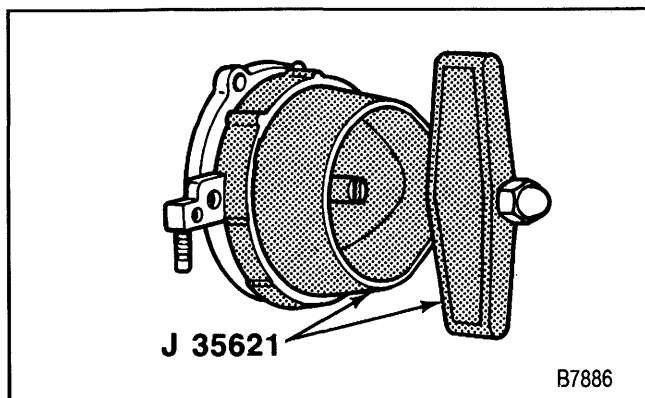


Figure 26—Installing the Crankshaft Rear Oil Seal

Install or Connect (Figure 26)

Tool Required:

J 35621 Seal Installer

1. Crankshaft rear oil seal (figure 26).
 - A. Lubricate the inner and outer diameter of the seal with engine oil.
 - B. Install the seal on J 35621.
 - C. Position J 35621 against the crankshaft. Thread the attaching screws into the tapped holes in the crankshaft.
 - D. Tighten the screws securely with a screwdriver. This will ensure that the seal is installed squarely over the crankshaft.
 - E. Turn the handle until it bottoms.
 - F. Remove J 35621.
2. Clutch and flywheel or flexplate, as equipped. Refer to SECTION 7C.
3. Transmission. Refer to SECTION 7.

CRANKSHAFT REAR OIL SEAL RETAINER REPLACEMENT

Remove or Disconnect (Figures 25, 26, and 27)

1. Transmission. Refer to SECTION 7.
2. Clutch and flywheel or flexplate, as equipped. Refer to SECTION 7C.
3. Oil pan. Refer to "Oil Pan Replacement."
4. Screws (80) and nuts (81).
5. Seal retainer (82).
6. Gasket (84).
7. Crankshaft rear oil seal. Insert a screwdriver into the notches provided in the seal retainer and pry the seal out (figure 25).

Clean

- Gasket surfaces on block and seal retainer.

Important

- Whenever the seal retainer is removed, a new retainer gasket and crankshaft rear oil seal must be installed.

Install or Connect (Figures 25, 26, and 27)

1. Gasket (84) to the block. It is not necessary to use sealant to hold the gasket in place.
2. Seal retainer (82).

Notice: Refer to "Notice" on page 6A3-1.

3. Screws (80) and nuts (81).

Tighten

- Screws (80) and nuts (81) to 15 N.m (11 lbs. ft.).

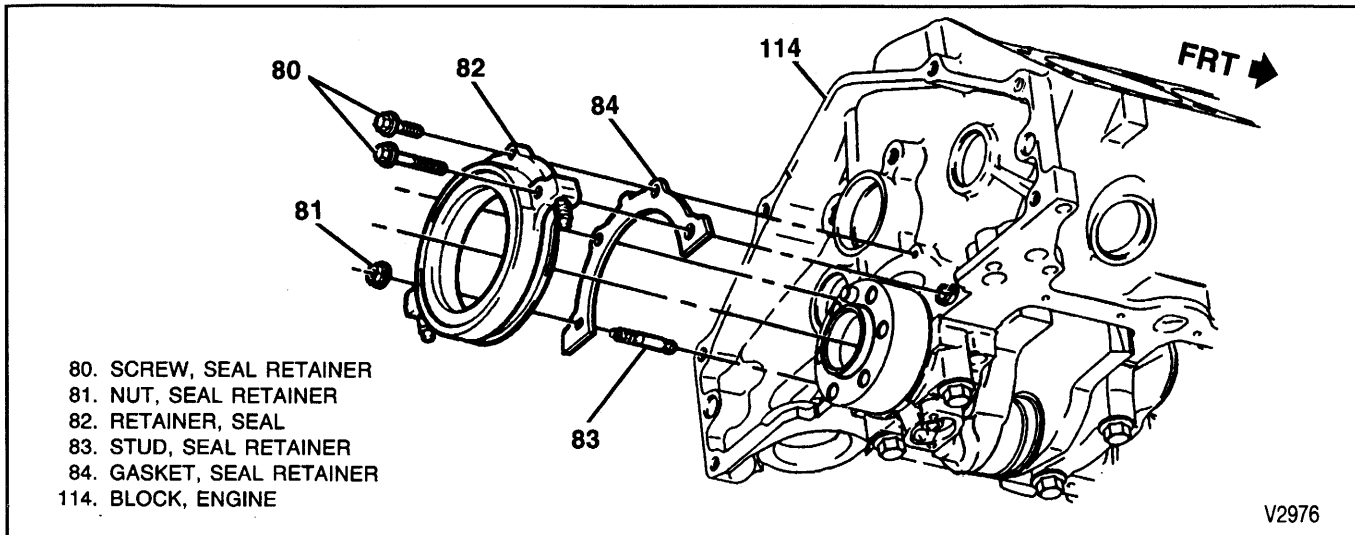


Figure 27—Crankshaft Rear Oil Seal Retainer

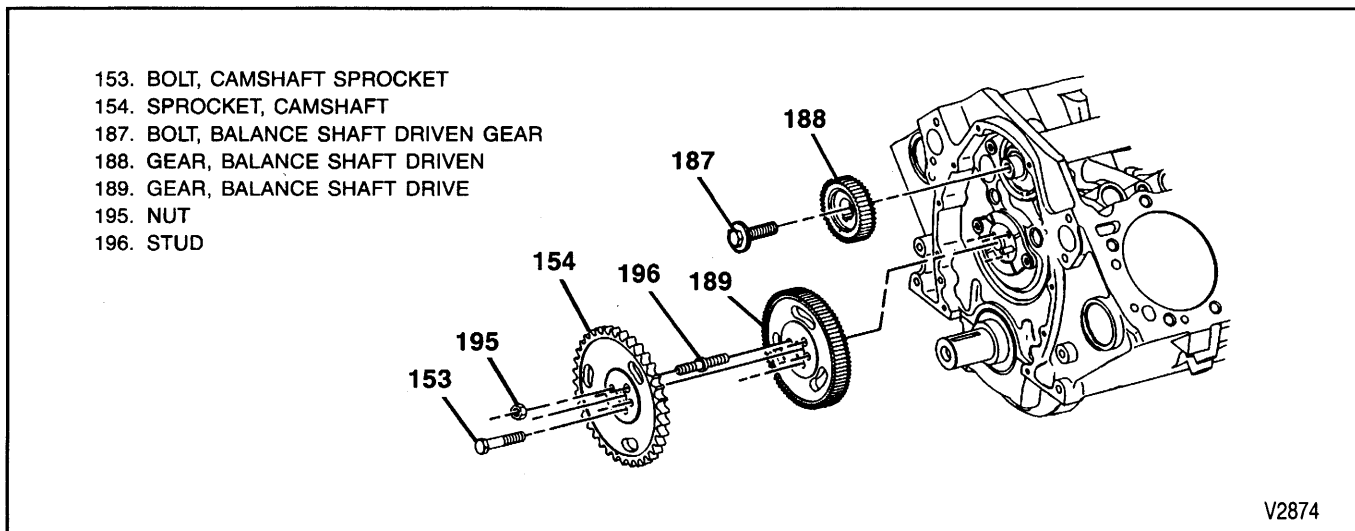


Figure 28—Balance Shaft Drive and Driven Gears

4. Oil pan. Refer to "Oil Pan Replacement."
5. Crankshaft rear oil seal. Refer to "Crankshaft Rear Oil Seal Replacement."
6. Clutch and flywheel or flexplate, as equipped. Refer to SECTION 7C.
7. Transmission. Refer to SECTION 7.

BALANCE SHAFT REPLACEMENT

- ↔ Remove or Disconnect (Figures 28 through 36)

Tools Required:

- J 39046 Torsional Damper Puller and Installer.
- J 26941 Bearing Remover.
- J 38834 Balance Shaft Bearing Service Kit.
- 1. Negative battery cable. Refer to SECTION 0A.
- 2. Air cleaner.
- 3. Fan, shroud, and radiator. Refer to SECTIONS 6B1 and 6B2.
- 4. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

5. Coolant pump. Refer to SECTION 6B1.
6. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."
7. Front cover. Refer to "Torsional Damper and Front Cover Replacement."
8. Distributor. Refer to SECTION 6D4.
9. Intake manifold. Refer to "Intake Manifold Replacement."
10. Camshaft sprocket bolts and nut.
11. Timing chain, camshaft sprocket, and balance shaft drive gear.
12. Balance shaft driven gear (figure 28).
13. Balance shaft retainer.
14. Lifter retainer.
15. Balance shaft and front bearing using a soft faced hammer (figure 30).
16. Balance shaft rear bearing using J 38834 (figures 31 and 32).

! Important

- The balance shaft and front bearing are serviced only as an assembly.

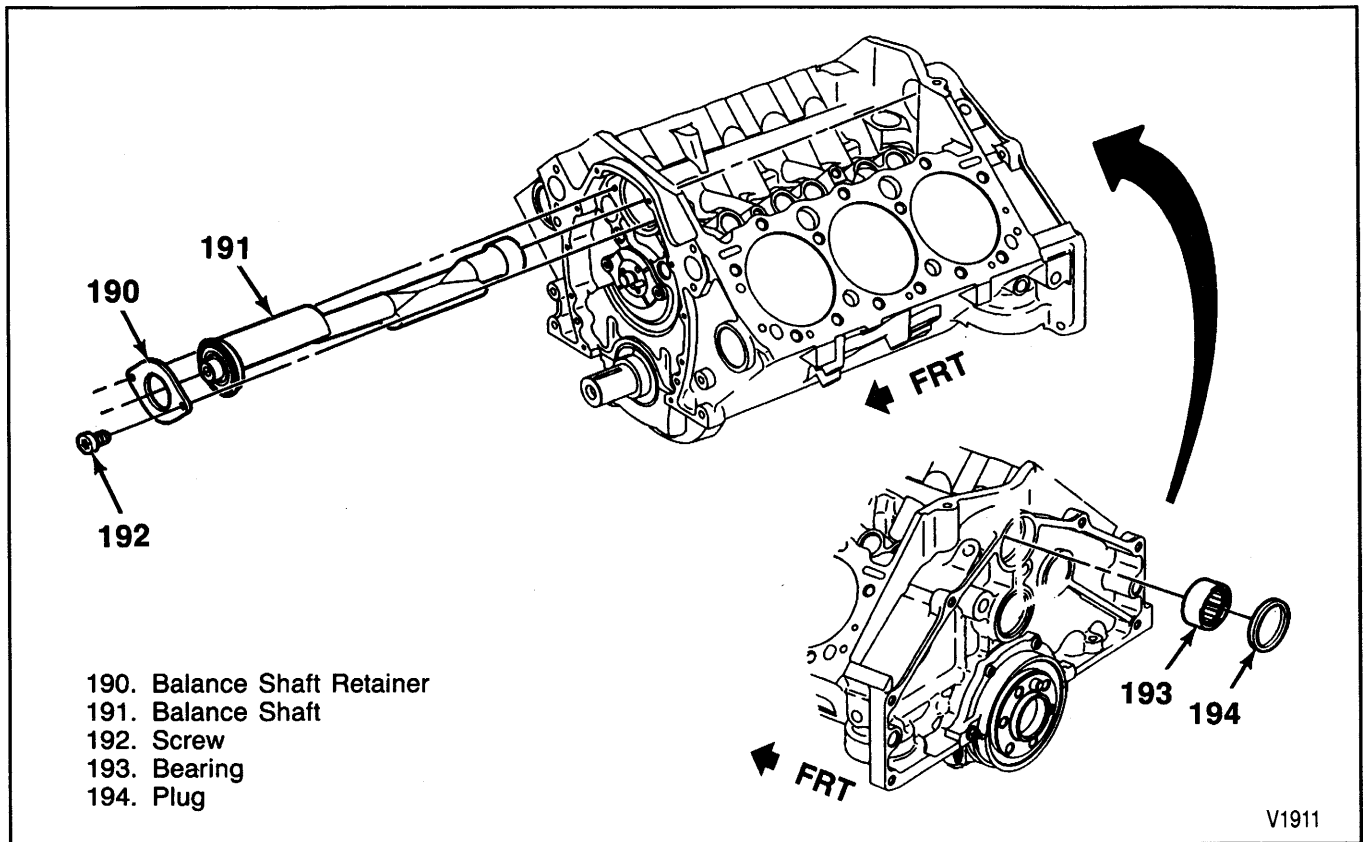


Figure 29—Balance Shaft Assembly

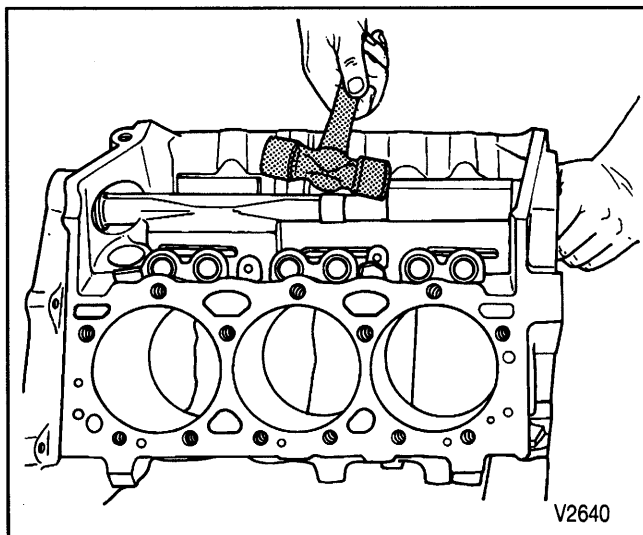


Figure 30—Removing The Balance Shaft

- Use only the correct tools for bearing and shaft replacement.
- The front bearing must not be removed from the balance shaft.
- The balance shaft drive and driven gears are serviced only as a set. The set includes the balance shaft driven gear bolt.



Clean

- All traces of old gasket material from gasket sealing surfaces.



Inspect

- Balance shaft drive and driven gears for nicks and burrs.



Install or Connect (Figures 33 through 36)

NOTICE: For steps 3, 4, 9, and 11, refer to "Notice" on page 6A3-1.

Tools Required:

- J 39046 Torsional Damper Puller and Installer.
- J 38834 Balance Shaft Bearing Service Kit.
- J 36996 Shaft Installer
- J 8092 Driver Handle
- J 36660 Torque/Angle Meter

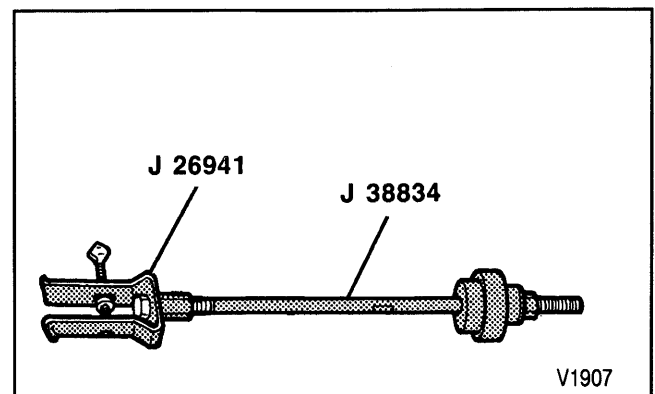


Figure 31—J 38834 Positioned to Remove Balance Shaft Rear Bearing

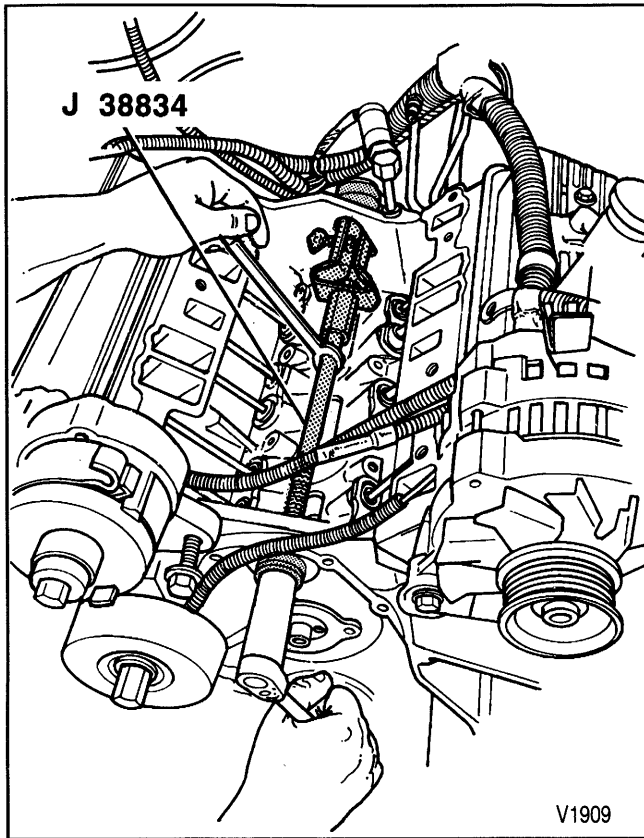


Figure 32—Removing Balance Shaft Rear Bearing

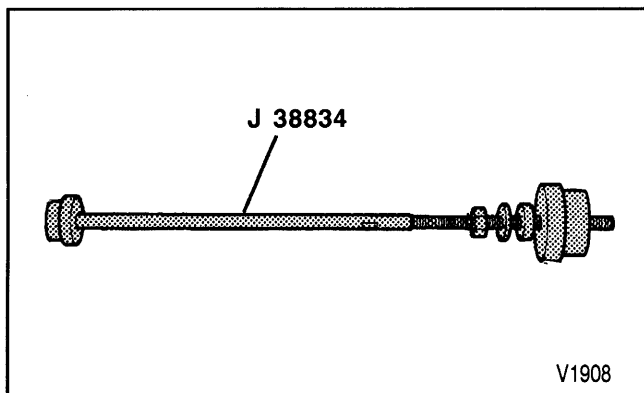


Figure 33—J 38834 Positioned to Install Balance Shaft Rear Bearing

1. Balance shaft rear bearing using J 38834 (figures 33 and 34).

- Dip the bearing in clean engine oil before installation.

2. Balance shaft into the block using J 36996 and J 8092 (figure 35).

- Dip the front balance shaft bearing into clean engine oil before assembly.

3. Balance shaft bearing retainer and bolts.



Tighten

- Bolts to 14 N·m (120 lbs. in.).

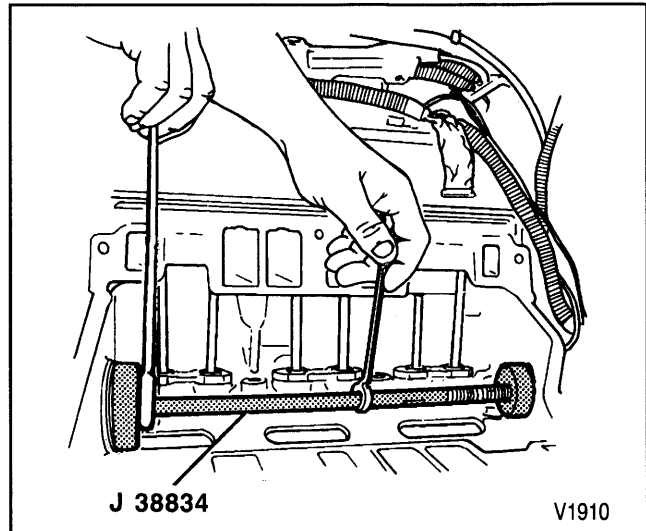


Figure 34—Installing Balance Shaft Rear Bearing

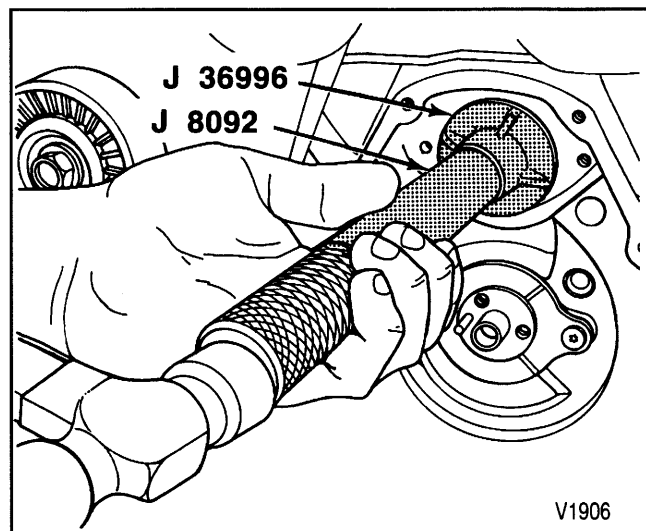


Figure 35—Installing the Balance Shaft

4. Balance shaft driven gear and bolt.



Tighten

- Bolt to 20 N·m (15 lbs. ft.) plus an additional turn of 35 degrees using J 36660.

5. Lifter retainer.

- Rotate the balance shaft by hand to make sure there is clearance between the balance shaft and the lifter retainer. Replace the lifter retainer if necessary.

6. Turn the camshaft so, with the balance shaft drive gear temporarily installed, its timing mark is straight up (figure 36).

7. With the balance shaft drive gear removed, turn the balance shaft so the timing mark on the driven gear points straight down (figure 36).

8. Balance shaft drive gear onto the camshaft.



Important

- Make sure that the timing marks on the balance shaft drive gear and the driven gear line up dot to dot (figure 36).

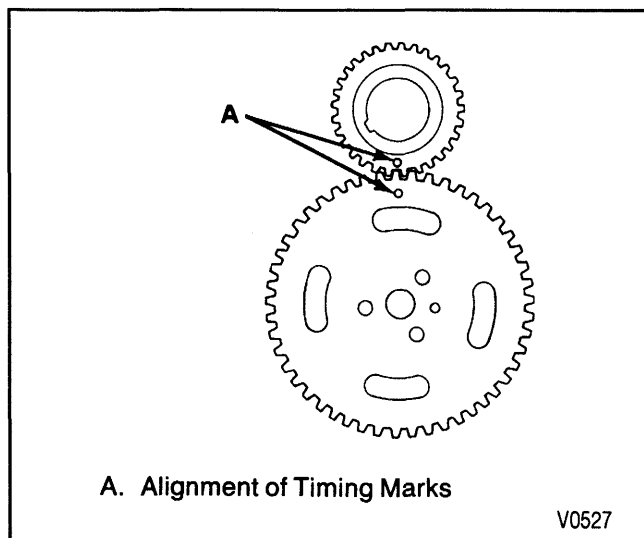


Figure 36—Balance Shaft Timing Marks

9. Balance shaft drive gear retaining stud.



Tighten

- Stud to 16 N·m (12 lbs. ft.).

10. Camshaft sprocket and timing chain.



Important

- Line up the timing marks on the camshaft sprocket and crankshaft sprocket dot to dot (figure 39). When these marks are lined up dot to dot, the number four cylinder is at top dead center of its compression stroke. The distributor rotor will need to be positioned facing the number four terminal on the distributor cap when installed.

11. Camshaft sprocket bolts and nut.



Tighten

- Bolts and nut to 28 N·m (21 lbs. ft.).

12. Intake manifold. Refer to "Intake Manifold Replacement."
 13. Distributor. Refer to SECTION 6D4.
 14. Front cover. Refer to "Torsional Damper and Front Cover Replacement."
 15. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."
 16. Coolant pump. Refer to SECTION 6B1.
 17. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
 18. Fan, shroud, and radiator. Refer to SECTIONS 6B1 and 6B2.
 19. Air cleaner.
 20. Negative battery cable.

- Fill crankcase with proper quantity and grade of engine oil. Refer to SECTION 0B.
- Fill cooling system with proper quantity and grade of coolant. Refer to SECTION 0B.

MEASURING CAMSHAFT LOBE LIFT

Tool Required:

J 8520 Camshaft Lobe Lift Indicator

1. Remove the rocker arm. Refer to "Rocker Arm Cover Replacement."
2. Refer to figure 37. Position the dial indicator (part of J 8520) so the plunger rests on the pushrod end, as shown. Make sure the pushrod is in the lifter socket.
3. Rotate the crankshaft slowly in the direction of rotation until the lifter is on the heel of the cam lobe. At this point, the pushrod will be in its lowest position.
4. Set dial indicator on zero, then rotate the crankshaft slowly, or attach an auxiliary starter switch, and "bump" the engine over until the pushrod is in the fully raised position.



Important

- Whenever the engine is cranked remotely at the starter, with a special jumper cable or other means, the distributor primary lead should be disconnected from the ignition coil.
5. Compare the total lift recorded from the dial indicator with specifications.
 6. If camshaft readings for all lobes are within specifications, remove the dial indicator assembly.
 7. Install the rocker arm and adjust the valves. Refer to "Valve Adjustment."

CAMSHAFT REPLACEMENT



Remove or Disconnect (Figures 38 through Figure 41)

Tool Required:

J 5825-A Crankshaft Sprocket Puller

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
3. Fan, shroud, and radiator. Refer to SECTIONS 6B1 and 6B2.
4. Rocker arm covers. Refer to "Refer to Rocker Arm Cover Replacement."

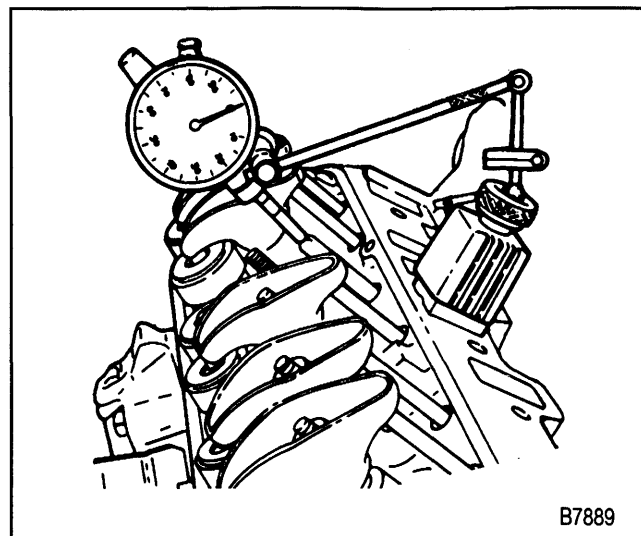
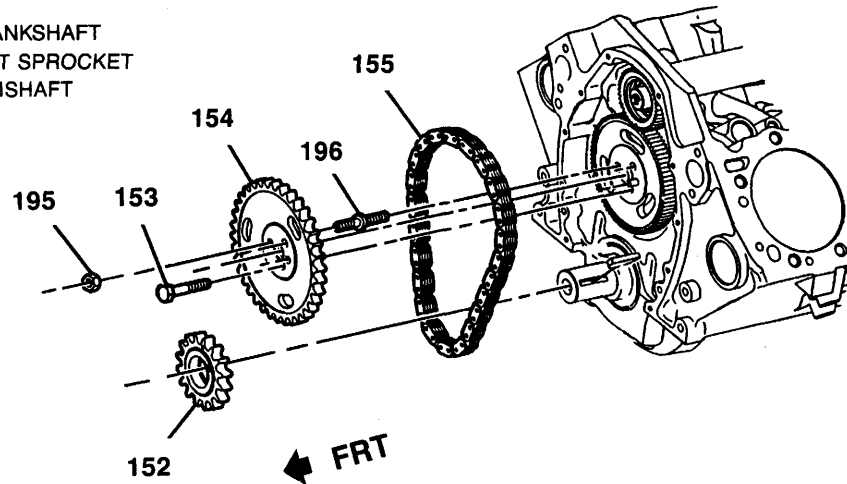


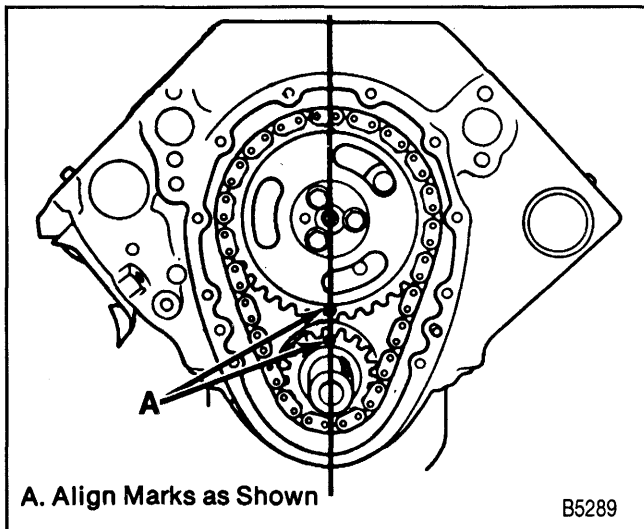
Figure 37—Measuring Camshaft Lobe Lift

- 152. SPROCKET, CRANKSHAFT
- 153. BOLT, CAMSHAFT SPROCKET
- 154. SPROCKET, CAMSHAFT
- 155. CHAIN, TIMING
- 195. NUT
- 196. STUD



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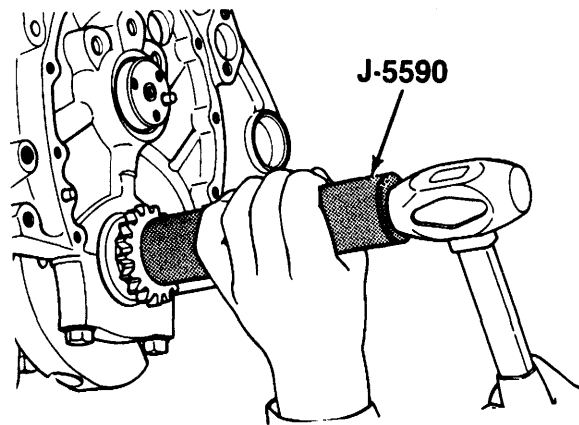
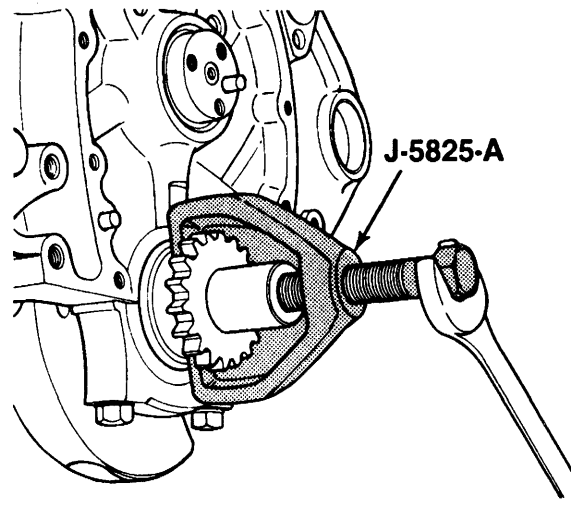
Figure 38—Camshaft and Components



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Figure 39—Timing Mark Alignment

5. Coolant pump. Refer to SECTION 6B1.
6. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."
7. Front cover. Refer to "Torsional Damper and Front Cover Replacement."
8. Distributor. Refer to SECTION 6D4.
9. Intake manifold. Refer to "Intake Manifold Replacement."
10. Pushrods and hydraulic lifters. Refer to "Hydraulic Lifter Replacement."
 - Align the timing marks (figure 39).
11. Camshaft sprocket bolts.
12. Camshaft sprocket and timing chain. The sprocket is a light interference fit on the camshaft. Tap the sprocket on its lower edge to loosen it.
13. Screws (88) and thrust plate (87).
14. Crankshaft sprocket (if required). Use J 5825-A (figure 40).
15. Camshaft.
 - Install two or three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft threaded holes. Use these bolts to handle the camshaft (figure 41).



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Figure 40—Replacing the Crankshaft Sprocket

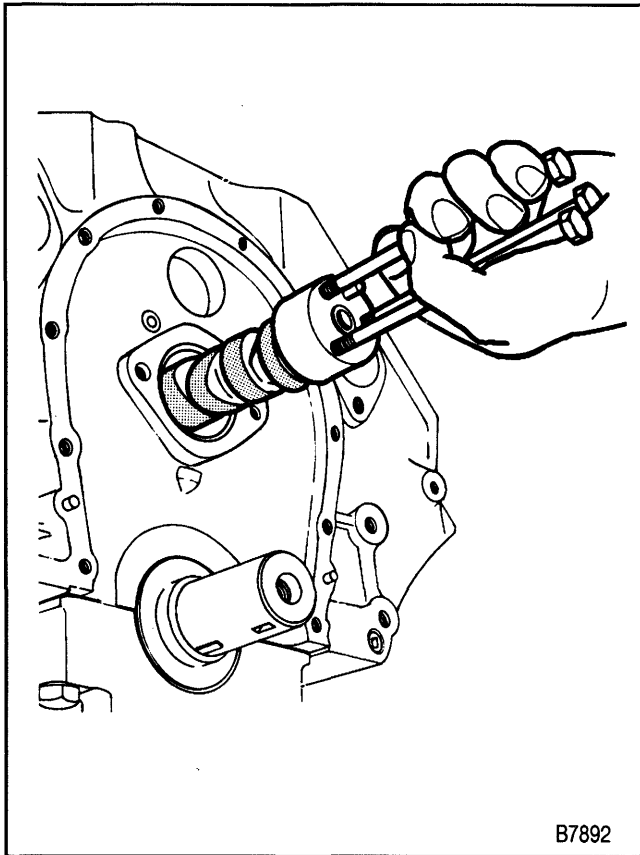


Figure 41—Replacing the Camshaft

- Pull the camshaft from the block. Use care to prevent damage to the camshaft bearings.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the camshaft and related components, as outlined in the Light Duty Truck Unit Repair Manual.

The Light Duty Truck Unit Repair Manual also describes camshaft bearing replacement.

Install or Connect (Figures 38 through 41)

Notice: For steps 4 and 6, refer to "Notice" on page 6A3-1.

Tool Required:

J 5590 Crankshaft Sprocket Installer

- Coat the camshaft lobes and journals with High Viscosity Oil with Zinc (GM P/N 12345501) or equivalent.
1. Two or three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft threaded holes. Use these bolts to handle the camshaft.
 2. Camshaft to the engine (figure 41). Handle the camshaft carefully to prevent damage to the camshaft bearings.
 3. Crankshaft sprocket (if removed). Use J 5590 (figure 40). Make sure the timing mark faces outside.
 4. Thrust plate (87) and screws (88).

Tighten

- Screws (88) to 12 N·m (105 lbs. in.).

5. Camshaft sprocket and timing chain.

Important

- Align the timing marks on the camshaft sprocket and crankshaft sprocket (figure 39).

6. Camshaft sprocket bolts.

Tighten

- Bolts to 28 N·m (21 lbs. ft.).

7. Hydraulic lifters and pushrods. Refer to "Hydraulic Lifter Replacement."

Important

- Replace all hydraulic lifters, change the engine oil and filter and add GM Engine Oil Supplement (GM P/N 1052367) or equivalent to the engine oil whenever a new camshaft is installed.

Adjust

- Valves. Refer to "Valve Adjustment."

8. Intake manifold. Refer to "Intake Manifold Replacement."

9. Distributor. Refer to SECTION 6D4.

10. Front cover. Refer to "Torsional Damper and Front Cover Replacement."

11. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."

12. Coolant pump. Refer to SECTION 6B2.

13. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

14. Fan, shroud and radiator. Refer to SECTION 6B1 and SECTION 6B2.

15. Air cleaner.

16. Negative battery cable.

CONNECTING ROD AND PISTON REPLACEMENT

Remove or Disconnect (Figure 42)

Tool Required:

J 5239 Guide Set

1. Cylinder head. Refer to "Cylinder Head Replacement."
2. Oil pan. Refer to "Oil Pan Replacement."
3. Oil pump (if necessary). Refer to "Oil Pump Replacement."
4. Ridge or deposits from the upper end of the cylinder bores.
 - A. Turn the crankshaft until the piston is at BDC.
 - B. Place a cloth on top of the piston.
 - C. Perform the cutting operation with a ridge reamer.
 - D. Turn the crankshaft until the piston is at TDC.
 - E. Remove the cloth and cuttings.

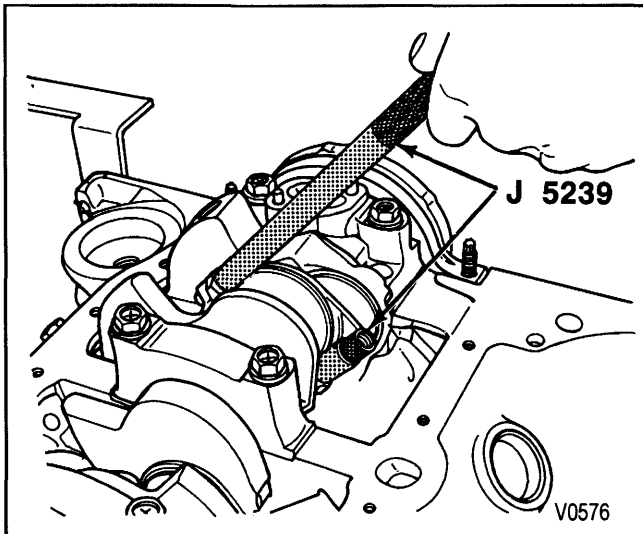


Figure 42—Guiding the Connecting Rod

5. Connecting rod cap. Check the connecting rod and cap for identification marks. Mark the parts if required. The connecting rod and cap must be kept together as mating parts.
6. Connecting rod and piston.

- Attach J 5239 to the connecting rod bolts (figure 42).
- Use the long guide rod of J 5239 to push the connecting rod and piston out of the bore.

7. Connecting rod bearing.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the components as necessary. Measure connecting rod bearing clearance, piston clearance, ring clearances, etc. Refer to the Light Duty Truck Unit Repair Manual.

The Light Duty Truck Unit Repair Manual contains information on:

- Connecting rod and piston.
- Piston rings.
- Connecting rod and crankpin.
- Cylinder bores.

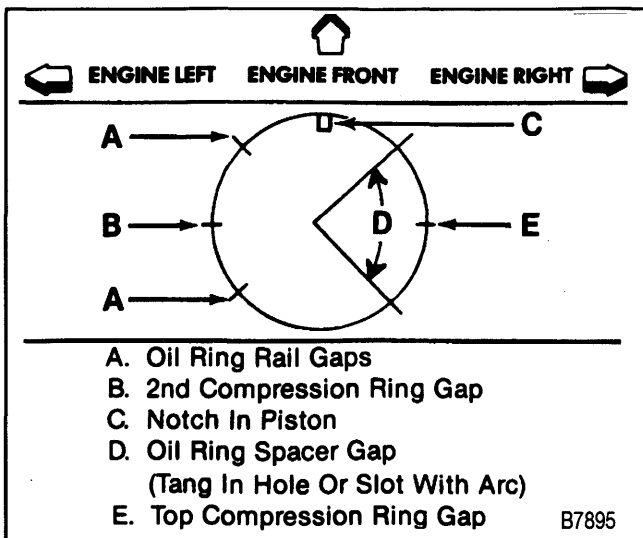


Figure 43—Piston Ring End Gap Locations

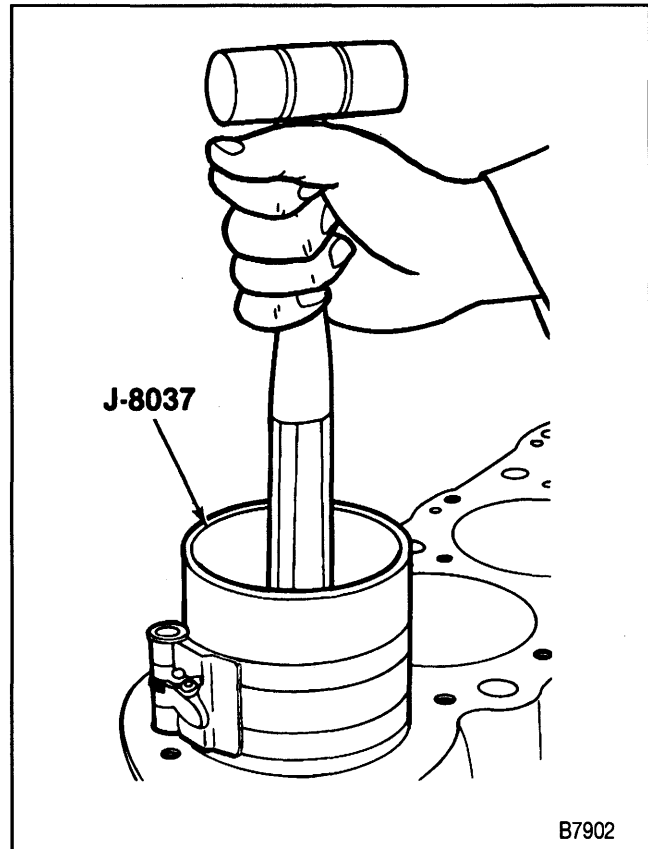


Figure 44—Installing the Piston

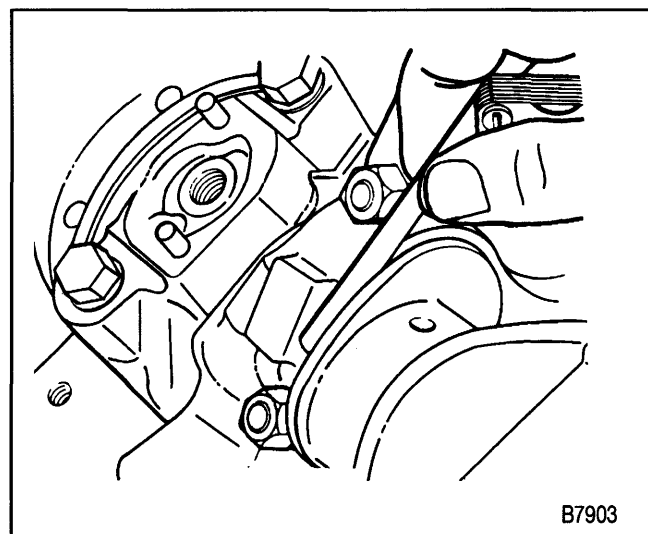


Figure 45—Measuring Connecting Rod Side Clearance

Install or Connect (Figures 42 through 45)

Tools Required:

- J 5239 Connecting Rod Guide Set
- J 8037 Ring Compressor
- J 36660 Torque/Angle Meter

- Make sure the cylinder walls are clean. Lubricate the cylinder wall lightly with engine oil.
- Make sure the piston is installed in the matching cylinder.

1. Connecting rod bearings.

- A. Make sure the bearing inserts are the right size.
 - B. Install the bearing inserts in the connecting rod and connecting rod cap.
 - C. Lubricate the bearings with engine oil.
2. Piston and connecting rod to the proper bore.
- A. With the connecting rod cap removed, install J 5239 onto the connecting rod bolts.
 - B. Locate the piston ring end gaps as shown in figure 43.
 - C. Lubricate the piston and rings with engine oil.
 - D. Without disturbing the ring end gap location, install J 8037 over the piston (figure 44).
 - E. The piston must be installed so the notch in the piston faces the front of the engine (figure 43).
 - F. Place the piston in its matching bore. The connecting rod bearing tang slots must be on the side opposite the camshaft. Using light blows with a hammer handle, tap the piston down into its bore (figure 44). At the same time, from beneath the vehicle guide the connecting rod to the crankpin with J 5239 (figure 42). Hold the ring compressor against the block until all rings have entered the cylinder bore.
3. Remove J 5239 from the connecting rod bolts.



Important

- Each connecting rod and bearing cap should be marked, beginning at the front of the engine. Cylinders 1, 3, and 5 are the left bank and, 2, 4, and 6 are the right bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new connecting rod bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.



Measure

- Connecting rod bearing clearance. Refer to the Light Duty Truck Unit Repair Manual.
4. Connecting rod cap and bearing.

Notice: Refer to "Notice" on page 6A3-1.

5. Connecting rod bolt nuts.



Tighten

- Connecting rod bolt nuts to 27 N·m (20 lbs. ft.).
- Connecting rod bolt nuts an additional 70 degrees using J 36660.



Inspect

- Connecting rod side clearance. Use a feeler gage between the connecting rod and crankshaft (figure 45).
- The correct clearance is 0.006-0.014 inch.

6. Oil pump (if removed). Refer to "Oil Pump Replacement."
7. Oil pan and cylinder head. Refer to "Oil Pan Replacement" and "Cylinder Head Replacement."

MAIN BEARING REPLACEMENT



Remove or Disconnect (Figure 46)

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Spark plugs. Refer to SECTION 6D4.
2. Oil pan. Refer to "Oil Pan Replacement."
3. Oil pump. Refer to "Oil Pump Replacement."
4. Main bearing caps.
 - Check the main bearing caps for location markings. Mark the caps if necessary. The caps must be returned to their original locations during assembly.
5. Lower main bearing inserts from the main bearing caps.
6. Upper main bearing inserts.
 - Insert J 8080 into the crankshaft oil hole (figure 46).
 - Rotate the crankshaft to "turn" the bearing insert out of the block.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the components as required. Refer to the Light Duty Truck Unit Repair Manual. The Light Duty Truck Unit Repair Manual contains information on:

- Crankshaft.
- Main and connecting rod bearings.

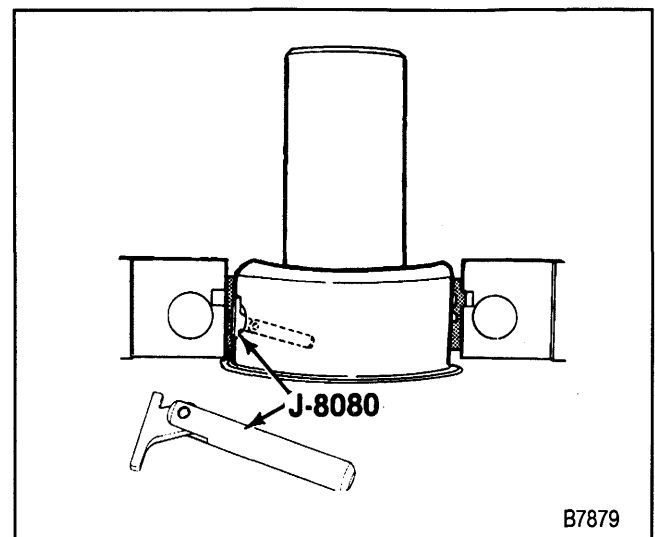


Figure 46—Removing the Main Bearing Insert

Install or Connect (Figures 46 and 47)

Notice: For steps 3 and 4, refer to "Notice" on page 6A3-1.

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Upper main bearing inserts.

- A. Insert J 8080 into a crankshaft main bearing oil hole (figure 46).
- B. Apply engine oil to inserts of the proper size.
- C. Insert the plain end (without the bearing tang) of the insert between the crankshaft and the notched side of the block.
- D. Rotate the crankshaft to "roll" the insert into the block.
- E. Remove the tool.

2. Lower main bearing inserts to the main bearing caps.

- Make sure the inserts are of the proper size.
- Apply engine oil to the inserts.

Adjust

- Main bearing clearance. Refer to the Light Duty Truck Unit Repair Manual. If the engine is in the vehicle, the crankshaft must be supported upward to remove any clearance from the upper bearing. The total clearance can then be measured between the lower bearing and journal.

3. Main bearing caps (except rear cap) and bolts to the block.

Tighten

- Main bearing cap bolts to 100 N.m (75 lbs. ft.).

4. Rear main bearing cap.

- A. Apply engine oil to the bearing insert.
- B. Install the rear main bearing cap and bolts.

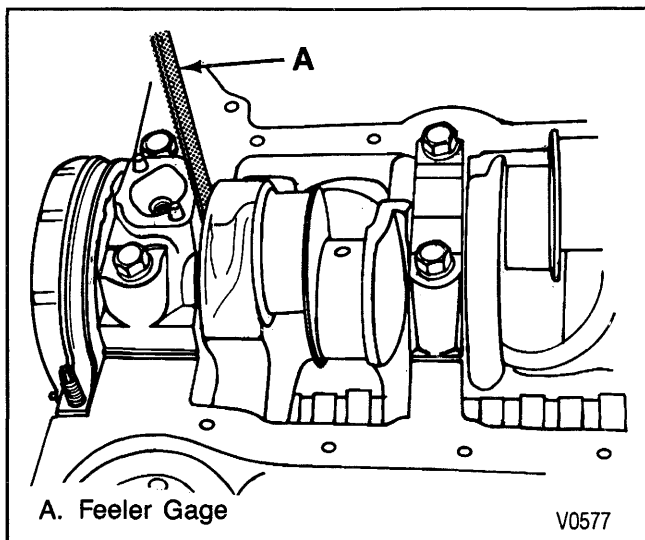


Figure 47—Measuring Crankshaft End Play

Tighten

- Rear main bearing cap bolts temporarily to 14 N.m (124 lbs. in.).

Adjust

• Crankshaft end play, as follows:

- A. Tap the end of the crankshaft first rearward then forward with a lead hammer. This will line up the rear main bearing and crankshaft thrust surfaces.
- B. Tighten the rear main bearing cap bolts to 100 N.m (75 lbs. ft.).
- C. With the crankshaft forced forward, measure at the front end of the rear main bearing with a feeler gage (figure 47). The proper clearance is 0.002-0.006 inch.
 - If correct end play cannot be obtained, make sure the correct size rear main bearing has been installed. Production engines may have rear main bearings that are 0.008-inch wider across the thrust faces than standard. Refer to the Light Duty Unit Repair Manual for more information.

5. Oil pump. Refer to "Oil Pump Replacement."

6. Oil pan. Refer to "Oil Pan Replacement."

7. Spark plugs. Refer to SECTION 6D4.

OIL FILTER ADAPTER AND BYPASS VALVE REPLACEMENT (MODELS WITH ENGINE OIL COOLER)

Remove or Disconnect (Figure 48)

1. Oil filter.

Inspect

- Bypass valve spring and fiber valve for proper operation, cracks, or other damage. If replacement is required, the bypass valve and oil filter adapter must be replaced as an assembly.

2. Oil cooler lines.

3. Bolts (93).

4. Oil filter adapter (92).

5. Gasket (91) and seal (90).

Install or Connect (Figure 48)

1. New gasket (91), new seal (90), and oil filter adapter (92) to the block.

Notice: Refer to "Notice" on page 6A3-1.

2. Bolts (93).

Tighten

- Bolts (93) to 20 N.m (15 lbs. ft.).
- 3. Oil cooler lines.
- 4. Oil filter.
- Add engine oil as needed.

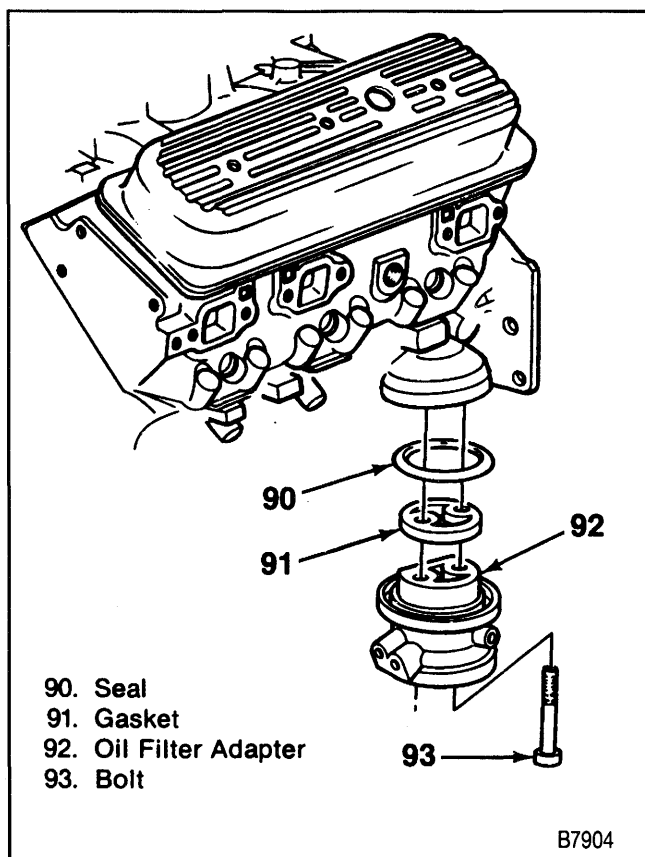


Figure 48—Oil Filter Adapter

CRANKSHAFT REPLACEMENT

1. Remove the engine. Refer to "Engine Replacement."
2. Refer to the Light Duty Truck Unit Repair Manual for crankshaft replacement procedures.

FLYWHEEL REPLACEMENT

Remove or Disconnect (Figure 49)

1. Transmission, flywheel housing and clutch. Refer to SECTION 7C.
2. Flywheel bolts.
3. Flywheel.

Clean

- Mating surfaces of crankshaft and flywheel. Remove any burrs.

Inspect

- Flywheel for burning, scoring, warping, and wear. Replace the flywheel if necessary. Do not machine the flywheel.
- Flywheel ring gear for worn or broken teeth.

FLYWHEEL RING GEAR REPLACEMENT

1. Use a torch to heat the gear around the entire circumference, then drive the gear off the flywheel, using care not to damage the flywheel.

NOTICE: Never heat starter gear to red hot as this will change metal structure.

2. Uniformly heat the flywheel gear to a temperature that will expand the gear to permit installation. Temperature must not exceed 204°C (400°F).
3. As soon as the gear has been heated, install it on the flywheel.

Install or Connect

1. Flywheel.

Notice: Refer to "Notice" on page 6A3-1.

2. Flywheel bolts.

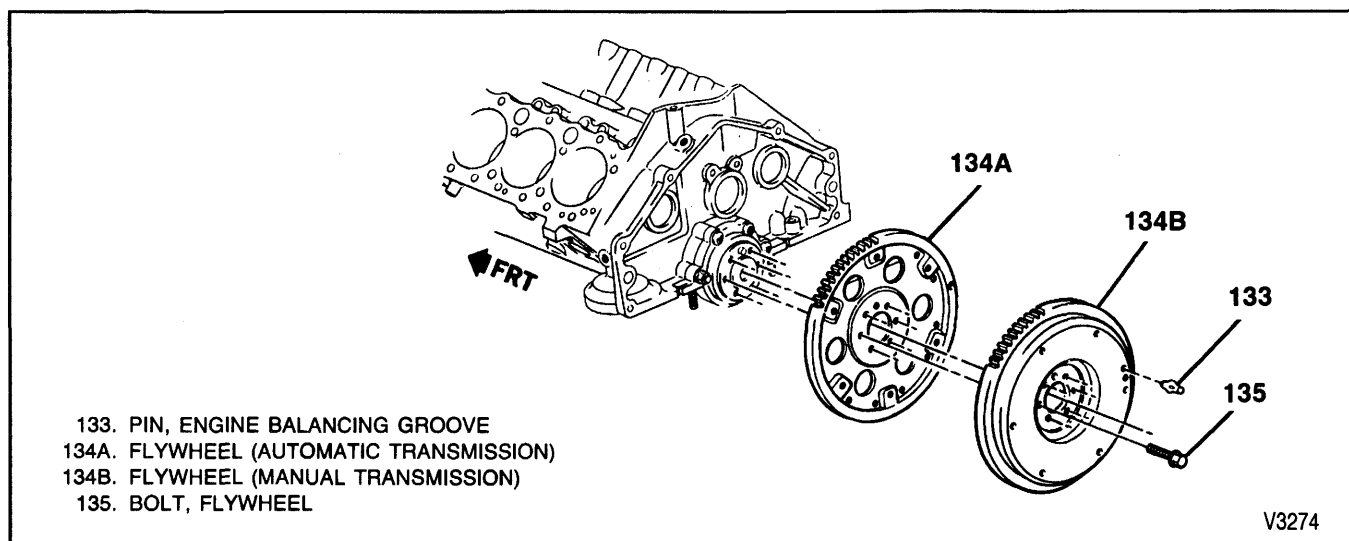


Figure 49—Flywheel or Flex Plate

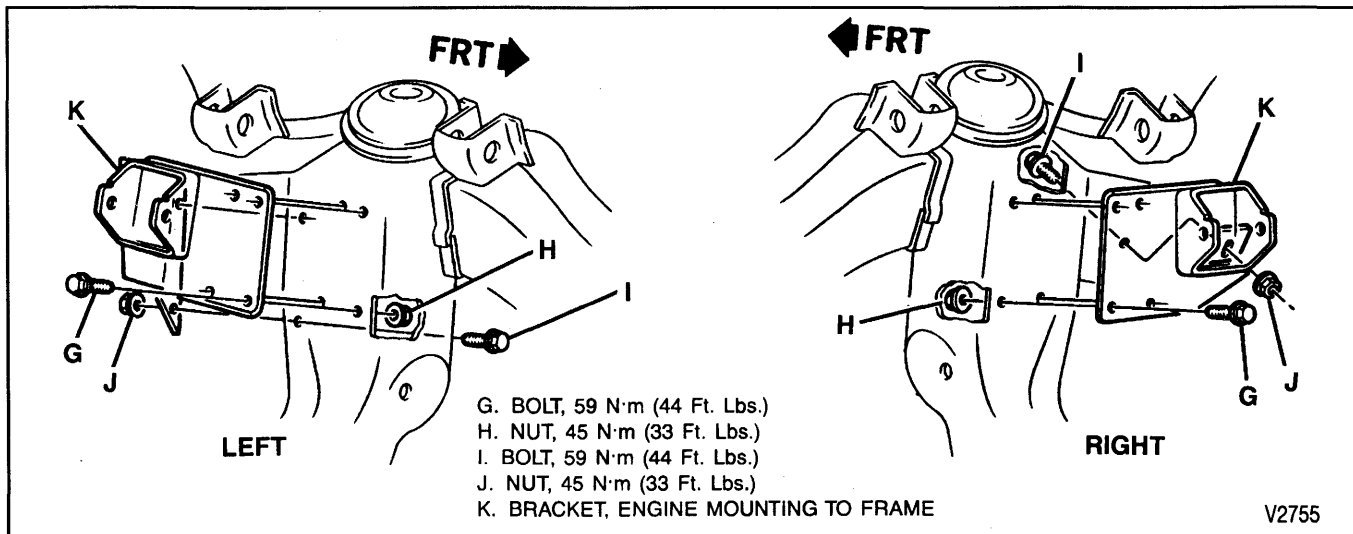


Figure 50—Front Engine Mounting Brackets to Frame (C1 and 2)

**Tighten**

- Flywheel bolts to 100 N·m (75 lbs. ft.).
- 3. Clutch, flywheel housing, and transmission. Refer to SECTION 7.

ENGINE MOUNTINGS

NOTICE: Broken or deteriorated mountings can cause misalignment and eventual destruction of certain drive train components. When a single mounting breakage occurs, the remaining mountings are subjected to abnormally high stresses.

INSPECTING ENGINE MOUNTINGS**Front Engine Mountings**

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

1. Raise the engine to remove weight from the mountings and to place a slight tension on the rubber cushion. Observe both mountings while raising the engine.
2. Replace the mounting if the following conditions exist:
 - Hard rubber surface is covered with heat check cracks.
 - Rubber cushion is separated from the metal plate of the mounting.
 - Rubber cushion is split through the center.
3. If there is movement between a metal plate of the mounting and its attaching points, lower the engine and tighten the bolts or nuts attaching the mounting to the engine, frame, or bracket.

Rear Mountings

1. Push up and pull down on the transmission tailshaft. Observe the transmission mounting.
2. Replace the mounting if the following conditions exist:
 - Rubber cushion is separated from the metal plate of the mounting.
 - Mounting is bottomed out (tailshaft can be moved up but not down).
3. If there is relative movement between a metal plate of the mounting and its attaching point, tighten the bolts or nuts attaching the mounting to the transmission or crossmember.

FRONT MOUNTING REPLACEMENT

Remove or Disconnect (Figures 50, 51, and 52)

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the engine with a suitable jack. Do not load the engine mounting.

1. Engine mounting through-bolt and nut.

NOTICE: Raise the engine only enough for sufficient clearance. Check for interference between the rear of the engine and the cowl panel which could cause distributor damage.

- Raise the engine only enough to permit removal of the engine mounting.
2. Mounting assembly bolts, nuts, and washers.
 3. Mounting assembly.

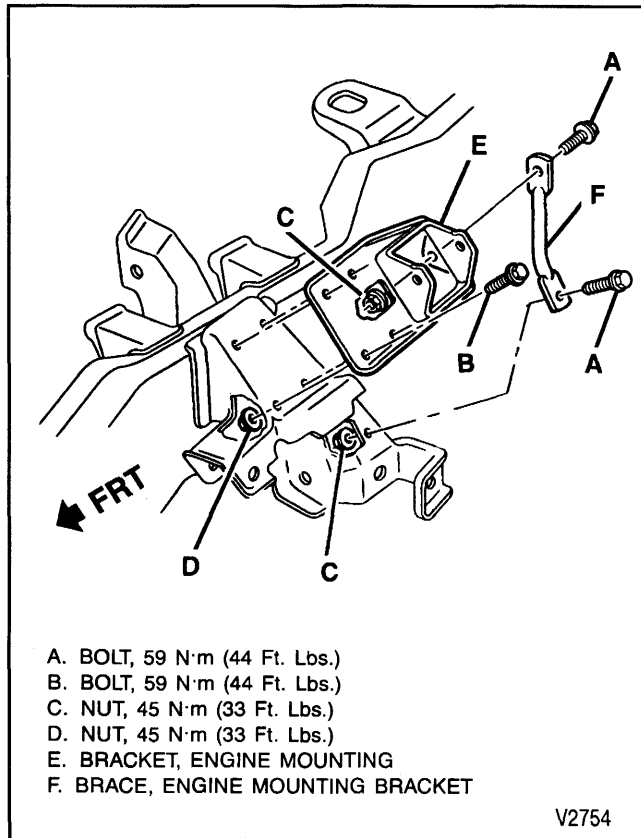


Figure 51—Front Engine Mounting Brackets to Frame (K1 and 2)

Install or Connect (Figures 50, 51, and 52)

1. Mounting assembly.

NOTICE: For steps 2 and 3, refer to "Notice" on page 6A3-1.

2. Mounting assembly bolts, nuts, and washers.



Tighten

- Fasteners to specifications (figures 50 and 51).

3. Engine mount through-bolt and nut. Lower the engine until the bolt can be inserted. Install the nut.



Tighten

- Through-bolt or nut to specifications (figure 52).

REAR MOUNTING REPLACEMENT

Remove or Disconnect (Figure 53)

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

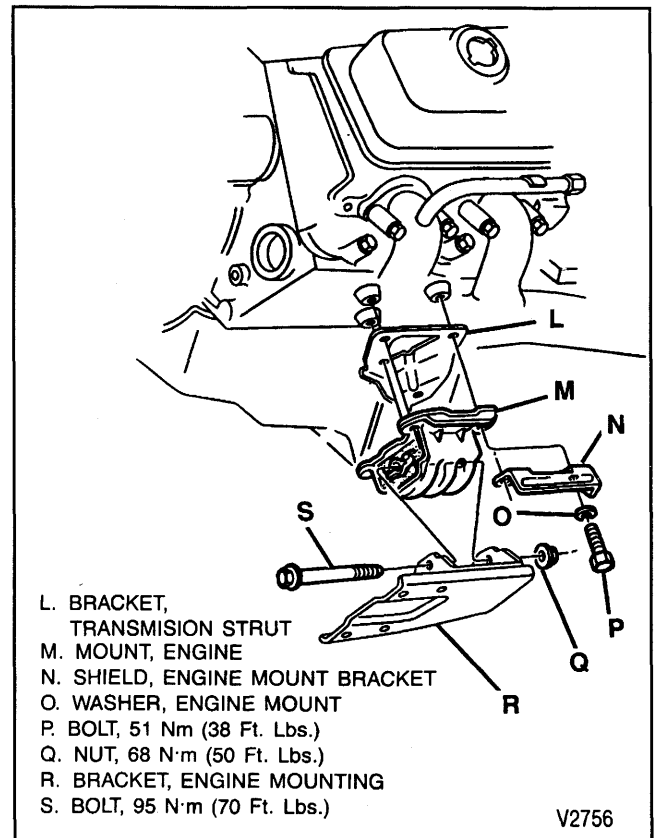


Figure 52—Front Engine Mounts to Brackets

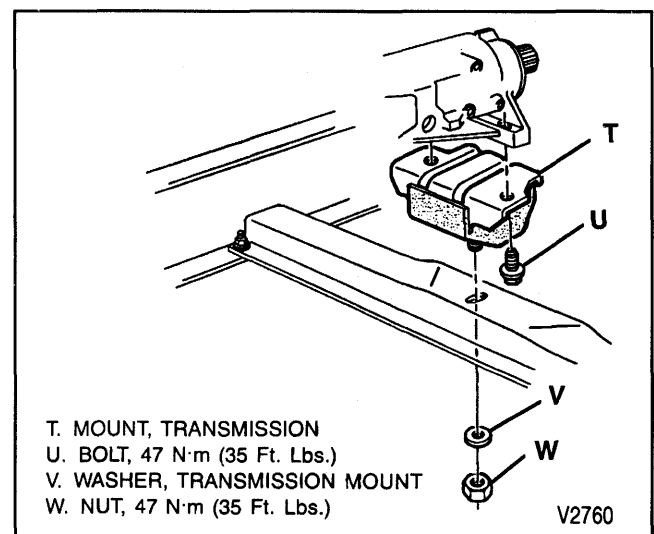


Figure 53—Rear Engine Mounting

- Support the rear of the engine to relieve the weight on the rear mountings.

1. Mounting to crossmember nut(s) and washer(s).
2. Mounting to transmission bolts and washers.
 - Raise the rear of the engine only enough to permit the removal of the mounting.
3. Mounting.

Install or Connect (Figure 53)

1. Mounting.
 - Lower the rear of the engine.

2. Mounting to transmission bolts and washers.

NOTICE: Refer to "Notice" on page 6A3-1.

3. Mounting to crossmember nut(s) and washer(s).



Tighten

- Fasteners to specifications. (Figure 53).

ENGINE REPLACEMENT



Remove or Disconnect (Figures 51 through 53)

1. Negative battery cable. Refer to SECTION 0A.
2. Hood. Refer to SECTION 2B.
 - Drain the cooling system. Refer to SECTION 6B1.
3. Air cleaner.
4. Accessory drive belt. Refer to SECTION 6B1.
5. Fan and coolant pump pulley. Refer to SECTION 6B1.
6. Radiator and shroud. Refer to SECTION 6B2.
7. Heater hoses at the engine. Refer to SECTION 6B1.
8. Accelerator cruise control and detent linkage (if used). Refer to SECTION 9B.
9. Air conditioning compressor (if used) and lay aside. Refer to SECTION 1B.
10. Power steering pump (if used) and lay aside. Refer to SECTION 3B.
11. Engine wiring harness from the engine.
12. Fuel line. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
13. Vacuum lines from the intake manifold. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
 - Raise the vehicle and support with safety stands.
 - Drain the crankcase oil.
14. Exhaust pipes from the manifolds. Refer to SECTION 6F.
15. Strut rods at the engine mountings (if used).
16. Flywheel or torque converter cover. Refer to SECTION 7.
17. Wiring along oil pan rail.
18. Starter motor. Refer to SECTION 6D2.
19. Wiring for fuel gage. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
20. Converter to flex plate bolts (automatic transmission). Refer to SECTION 7.
 - Lower the vehicle.
 - Support the transmission.
 - Attach a suitable lifting fixture to the engine.

21. Bell housing to engine bolts. Refer to SECTION 7.
22. Engine mounting to frame bolts. Refer to "Engine Mountings."
23. Hood. Refer to SECTION 2B.
24. Engine.



Install or Connect (Figures 50, 51, and 52)

1. Engine to the vehicle.
 - Raise the vehicle and support with safety stands.

NOTICE: Refer to "Notice" on page 6A3-1.

2. Engine mounting to frame bolts.



Tighten

- Fasteners to specifications (figures 50, 51, and 52).
3. Bell housing to engine bolts. Remove the transmission support. Refer to SECTION 7.
 4. Converter to flex plate bolts. Refer to SECTION 7.
 5. Fuel gage wiring. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
 6. Starter motor. Refer to SECTION 6D2.
 7. Wiring along oil pan rail.
 8. Flywheel or torque converter cover. Refer to SECTION 7.
 9. Strut rods at the engine mountings (if used).
 10. Exhaust pipes to the manifolds. Refer to SECTION 6F.
 - Lower the vehicle.
 11. Vacuum lines to the intake manifold. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
 12. Fuel line. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
 13. Engine wiring harness. Refer to SECTION 6D5.
 14. Power steering pump (if used). Refer to SECTION 3B.
 15. Air conditioning compressor (if used). Refer to SECTION 1B.
 16. Accelerator, cruise control, and detent linkages. Refer to SECTION 9B.
 17. Heater hoses. Refer to SECTION 6B1.
 18. Radiator and shroud. Refer to SECTION 6B2.
 19. Accessory drive belts. Refer to SECTION 6B1.
 20. Air cleaner. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
 21. Hood. Refer to SECTION 2B.
 22. Proper quantity and grade of coolant and crankcase oil.
 23. Negative battery cable.

THREAD REPAIR

Damaged threads may be reconditioned by drilling out, rethreading, and installing a suitable thread insert.

Tools Required:

General purpose thread repair kits are available commercially.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch, and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to required depth.



Important

- Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.

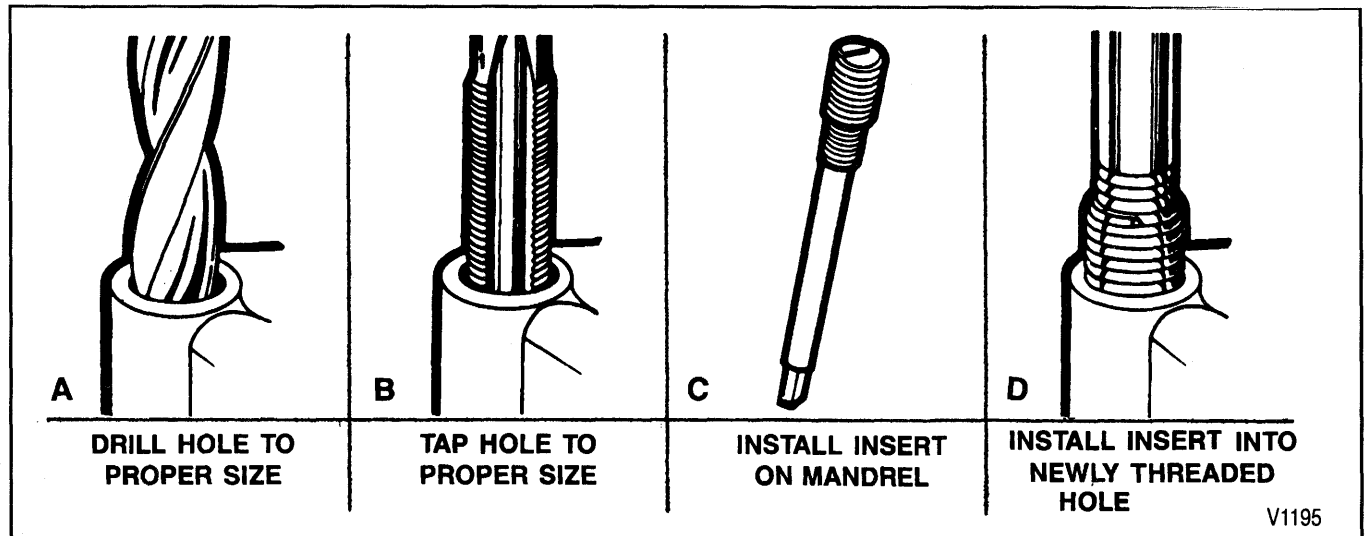


Figure 54—Repairing Thread Holes

2. Drill out damaged thread. Clean out chips.
3. Tap hole. Lubricate tap with light engine oil. Clean the thread.

! Important

- Avoid buildup of chips. Back out the tap every few turns and remove chips.
4. Thread the thread insert onto the mandrel of the installer (figure 54). Engage the tang of the insert onto the end of the mandrel.

5. Lubricate the insert with light engine oil (except when installing in aluminum) and install.

! Important

- When correctly installed, the insert should be flush to one turn below the surface.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

SPECIFICATIONS

ENGINE SPECIFICATIONS (4.3L)

All Specifications are in INCHES unless otherwise noted.

GENERAL DATA:				
Type			V6	
Displacement			4.3L (262 Cu. In.)	
RPO (VIN Code)			LB4 (Z)	
Bore			4.00	
Stroke			3.48	
Compression Ratio			9.3:1	
Firing Order			1-6-5-4-3-2	
Oil Pressure (Minimum)			6 psi @ 1000 RPM; 18 psi @ 2000 RPM; 24 psi @ 4000 RPM	
CYLINDER BORE:				
Diameter			4.0007-4.0017	
Out Of Round	Production		0.001 (Maximum)	
	Service		0.002 (Maximum)	
Taper	Production	Thrust Side	0.0005 (Maximum)	
		Relief Side	0.001 (Maximum)	
	Service		0.001 (Maximum)	
PISTON:				
Clearance	Production		0.0007-0.0017	
	Service Limit		0.0027 (Maximum)	
PISTON RING:				
C O M P R E S S I O N	Groove Clearance	Production	Top	0.0012-0.0032
			2nd	
		Service Limit		0.0042 (Maximum)
	Gap	Production	Top	0.010-0.020
			2nd	0.010-0.025
		Service Limit		0.035 (Maximum)
O I L	Groove Clearance	Production		0.002-0.007
		Service Limit		0.008 (Maximum)
	Gap	Production		0.015-0.055
		Service Limit		0.065
PISTON PIN:				
Diameter			0.9270-0.9273	
Clearance In Piston	Production		0.0002-0.0007	
	Service Limit		0.001 (Maximum)	
Fit In Rod			0.0008-0.0016 Interference	
EXHAUST MANIFOLD:				
Surface Flatness			0.010 (Maximum)	
INLET MANIFOLD:				
Surface Flatness			0.010 (Maximum)	
CYLINDER HEAD:				
Surface Flatness			0.004 (Overall)	
BALANCE SHAFT:				
Front Bearing Journal Diameter			2.1648-2.1654	
Rear Bearing Journal Diameter			1.4994-1.500	
Rear Bearing Journal Clearance			0.001-0.0036	

SPECIFICATIONS

ENGINE SPECIFICATIONS (4.3L) (CONT.)

All Specifications are in INCHES unless otherwise noted.

DISPLACEMENT:			4.3L (LB4, VIN Z)
CRANKSHAFT:			
Main Journal	Diameter	#1	2.4484-2.4493
		#2, #3	2.4481-2.4490
		#4	2.4479-2.4488
	Taper	Production	0.0002 (Maximum)
		Service Limit	0.001 (Maximum)
	Out Of Round	Production	0.0002 (Maximum)
Service Limit		0.001 (Maximum)	
Main Bearing Clearance	Production	#1	0.0008-0.0020
		#2, #3	0.0011-0.0023
		#4	0.0017-0.0032
	Service Limit	#1	0.0010-0.0015
		#2, #3	.0010-0.0025
		#4	0.0025-0.0035
Crankshaft End Play			0.002-0.006
Crankshaft Runout			0.001 (Maximum)
Crankpin	Diameter		2.2487-2.2497
	Taper	Production	0.0005
		Service Limit	0.001 (Maximum)
	Out Of Round	Production	0.0005
		Service Limit	0.001 (Maximum)
Rod Bearing Clearance	Production		0.0013-0.0035
	Service Limit		0.0030
Rod Side Clearance			0.006-0.014
CAMSHAFT:			
Lobe Lift ± 0.002	Intake		0.234
	Exhaust		0.257
Journal Diameter			1.8682-1.8692
			0.004-0.012
VALVE SYSTEM:			
Lifter			Hydraulic
Rocker Arm Ratio			1.50:1
Valve Lash		Intake	1 3/4 Turn Down from Zero Lash
		Exhaust	
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			0.002 (Maximum)
Seat Width		Intake	0.035-0.060
		Exhaust	0.062-0.093
Stem Clearance	Production	Intake	0.0010-0.0027
		Exhaust	0.0010-0.0027
	Service	Intake	High Limit Production +0.001
		Exhaust	High Limit Production +0.002
Valve Spring (Outer)	Free Length		2.03
	Pressure lbs. @ in.	Closed	76-84 lbs. @ 1.70-in.
		Open	194-206 lbs. @ 1.25-in.
	Installed Height ± 1/32"		1.690-1.710
Valve Spring Damper	Free Length		1.86
	Approx # of Coils		4

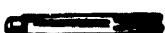
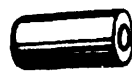
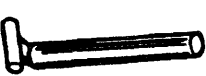
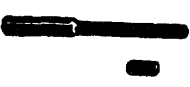
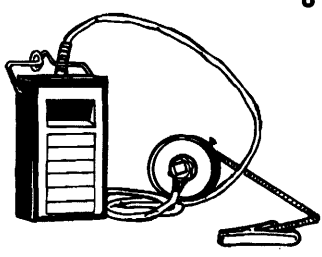
SPECIFICATIONS (CONT.)

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Lbs. Ft.	Lbs. In.
Balance Shaft Drive Gear Retaining Stud	16	12	—
Balance Shaft Driven Gear Bolt (Torque Plus 35°)	20	15	—
Balance Shaft Retainer Bolts	12	—	105
Camshaft Sprocket Bolts	28	21	—
Camshaft Thrust Plate Screws	12	—	106
Connecting Rod Bolt Nuts (Torque Plus 70°)	27	20	—
Coolant Outlet Bolts	28	21	—
Coolant Pump Bolts	40	30	—
Crankshaft Rear Oil Seal Retainer Screws and Nuts	15	—	133
Cylinder Head Bolts (In Sequence)	90	65	—
EGR Valve Bolt	23	17	—
EGR Valve Nut	23	17	—
EGR Valve Stud	15	11	—
Engine Block Drain Plug	30	22	—
Exhaust Manifold Bolts			
Center Two Bolts	36	26	—
All Other Bolts	28	20	—
Flywheel Bolts	100	75	—
Flywheel Housing Bolts	44	32	—
Front Cover Bolts	14	—	124
Hydraulic Lifter Restrictor Retainer Bolts	16	12	—
Intake Manifold Bolts (In Sequence)	48	35	—
Main Bearing Cap Bolts	110	75	—
Oil Filter Adapter Bolts	20	15	—
Oil Pan Bolts	11	—	97
Oil Pan Drain Plug	25	18	—
Oil Pan Nuts	23	17	—
Oil Pan Studs to Oil Seal Retainer or Engine Block	2	—	18
Oil Pump Bolt	90	65	—
Oil Pump Cover Bolts	9	—	80
Rocker Arm Cover Bolts	10	—	90
Spark Plugs	15	11	—
Torsional Damper Bolt	95	70	—

T2765

SPECIAL TOOLS

- | | | | | | |
|----|---|-----------|-----|---|----------|
| 1. |  | J 39046 | 10. |  | J 5715 |
| 2. |  | J 5892-C | 11. |  | J 6036 |
| 3. |  | J 23590 | 12. |  | J 6880 |
| 4. |  | J 35468 | 13. |  | J 5825-A |
| 5. |  | J 8080 | 14. |  | J 5590 |
| 6. |  | J 8037 | 15. |  | J 8520 |
| 7. |  | J 5239 | 16. |  | J 35621 |
| 8. |  | J 23738-A | 17. |  | J 36660 |
| 9. |  | J 5802-01 | | | |

1. TORSIONAL DAMPER REMOVER AND INSTALLER
2. VALVE SPRING COMPRESSOR
3. AIR ADAPTER
4. CRANKSHAFT SEAL INSTALLER AND CENTERING TOOL
5. MAIN BEARING REPLACER
6. PISTON RING COMPRESSOR
7. GUIDE SET
8. VACUUM PUMP
9. STUD REMOVER

10. REAMER (0.003-INCH OVERSIZE)
11. REAMER (0.013-INCH OVERSIZE)
12. STUD INSTALLER
13. CRANKSHAFT GEAR PULLER
14. CRANKSHAFT GEAR INSTALLER
15. DIAL INDICATOR ADAPTER
16. REAR CRANKSHAFT SEAL INSTALLER
17. TORQUE/ANGLE METER

NOTES

SECTION 6A4

5.0L AND 5.7L V8

RPO LO3, VIN H

RPO LO5, VIN K

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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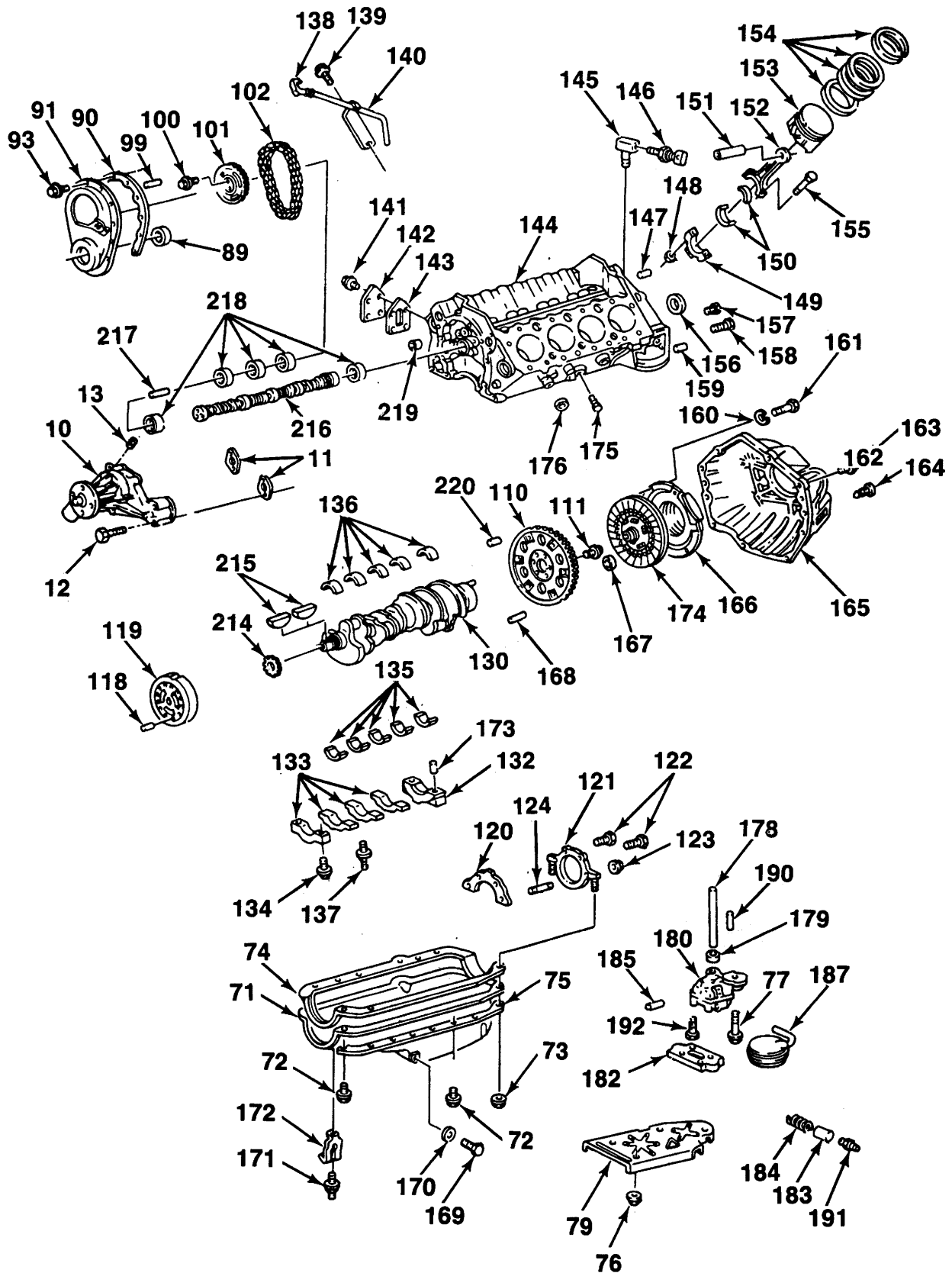
GENERAL DESCRIPTION

The small block engines covered in this section are available in two displacements; 5.0L (305 CID) and 5.7L (350 CID).

For engine identification, refer to SECTION 0A. For engine component identification, refer to figures 1 through 4.

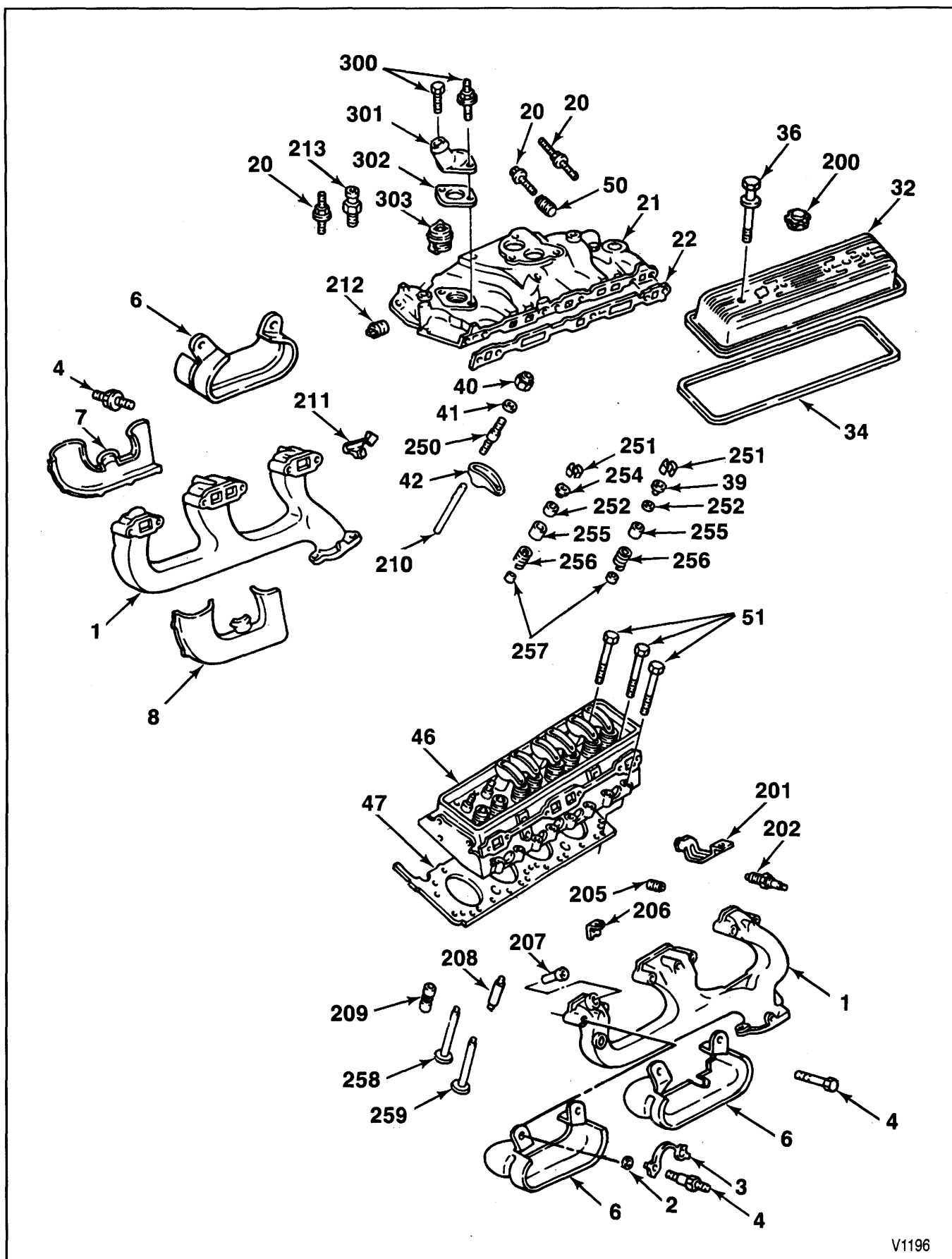
- | | |
|---|---|
| 10. Coolant Pump | 149. Connecting Rod Bearing Cap |
| 11. Coolant Pump Gasket | 150. Connecting Rod Bearing |
| 12. Coolant Pump Bolt | 151. Piston Pin |
| 13. Plug | 152. Connecting Rod |
| 71. Oil Pan | 153. Piston |
| 72. Bolt | 154. Piston Rings |
| 73. Nut | 155. Connecting Rod Bolt |
| 74. Oil Pan Gasket | 156. Expansion Cup Plug |
| 75. Reinforcement | 157. Plug |
| 76. Oil Pan Baffle Nut (H.D. 5.7L Only) | 158. Drain Plug |
| 77. Oil Pump Bolt | 159. Dowel Pin |
| 79. Oil Pan Baffle (H.D. 5.7L Only) | 160. Lock Washer |
| 89. Crankshaft Front Oil Seal | 161. Clutch Cover and Pressure Plate Bolt |
| 90. Front Cover Gasket | 163. Bolt |
| 91. Front Cover | 164. Clutch Fork Ball Stud |
| 93. Front Cover Bolt | 165. Clutch Housing |
| 99. Pin | 166. Clutch Pressure Plate Cover |
| 100. Camshaft Sprocket Bolt | 167. Clutch Pilot Bearing |
| 101. Camshaft Sprocket | 168. Flywheel Dowel Pin |
| 102. Timing Chain | 169. Oil Pan Drain Plug |
| 110. Flywheel | 170. Gasket |
| 111. Flywheel Bolt | 171. Oil Pan Stud |
| 118. Groove Pin | 172. Clamp (Automatic Transmission Only) |
| 119. Torsional Damper | 173. Spring Pin |
| 120. Rear Seal Retainer Gasket | 174. Clutch Driven Plate |
| 121. Crankshaft Rear Seal Retainer | 175. Plug |
| 122. Rear Seal Retainer Screw | 176. Expansion Cup Plug |
| 123. Rear Seal Retainer Nut | 178. Oil Pump Drive Shaft |
| 124. Rear Seal Retainer Stud | 179. Retainer |
| 130. Crankshaft | 180. Oil Pump |
| 132. Rear Main Bearing Cap | 182. Oil Pump Cover |
| 133. Main Bearing Cap | 183. Oil Pressure Regulator Valve |
| 134. Main Bearing Cap Bolt | 184. Regulator Valve Spring |
| 135. Lower Main Bearing Insert | 185. Spring Stop Retaining Pin |
| 136. Upper Main Bearing Insert | 187. Pick-Up Screen and Pipe |
| 137. Main Bearing Cap Stud (H.D. 5.7L Only) | 190. Pin |
| 138. Oil Level Indicator | 191. Regulator Valve Spring Stop Plug |
| 139. Bolt | 192. Bolt |
| 140. Oil Level Indicator Tube | 214. Crankshaft Sprocket |
| 141. Bolt | 215. Woodruff Key |
| 142. Fuel Pump Opening Cover | 216. Camshaft |
| 143. Fuel Pump Opening Cover Gasket | 217. Pin |
| 144. Engine Block | 218. Camshaft Bearings |
| 145. Fitting | 219. Oil Pressure Plug |
| 146. Oil Pressure and Fuel Pump Switch Sensor | 220. Groove Pin |
| 147. Plug | |
| 148. Nut | |

Figure 1—Cylinder Block and Components - Legend



V1202

Figure 2—Cylinder Block and Components



V1196

Figure 3—Cylinder Head, Manifolds, and Components

- | | |
|---------------------------------------|---------------------------------------|
| 1. Exhaust Manifold | 202. Spark Plug |
| 2. Washer | 205. Plug |
| 3. Exhaust Manifold Lock | 206. Spark Plug Wire Support |
| 4. Bolt/Stud | 207. Air Injection Pipe Extension |
| 6. Heat Shield | 208. Dowel Pin |
| 7. Outer Heat Stove | 209. Valve Lifter |
| 8. Inner Heat Stove | 210. Pushrod |
| 20. Bolt/Stud | 211. Spark Plug Wire Retainer Support |
| 21. Intake Manifold | 212. Drain Plug |
| 22. Intake Manifold Gasket | 213. Coolant Temperature Sensor |
| 32. Rocker Arm Cover | 250. Rocker Arm Stud |
| 34. Rocker Arm Cover Gasket | 251. Valve Stem Key |
| 36. Rocker Arm Cover Bolt | 252. Valve Stem Oil Seal (O-Ring) |
| 39. Inlet Valve Spring Cap | 254. Exhaust Valve Rotator |
| 40. Rocker Arm Nut | 255. Valve Stem Oil Shield |
| 41. Rocker Arm Ball | 256. Valve Spring with Damper |
| 42. Rocker Arm | 257. Valve Stem Oil Seal |
| 46. Cylinder Head | 258. Exhaust Valve |
| 47. Cylinder Head Gasket | 259. Inlet Valve |
| 50. Plug | 300. Bolt/Stud |
| 51. Cylinder Head Bolts | 301. Coolant Outlet |
| 200. Oil Filler Cap | 302. Gasket |
| 201. Spark Plug Wire Retainer Support | 303. Thermostat |

V1197

Figure 4—Cylinder Head, Manifolds, and Components - Legend

Small block engines are 90-degree V8 type, overhead valve, liquid cooled, with cast iron block and heads.

The crankshaft is supported by five precision insert main bearings, with crankshaft thrust taken at the number five (rear) bearing.

The camshaft is supported by five plain type bearings and is chain driven. Motion from the camshaft is transmitted to the valves by hydraulic lifters, pushrods, and ball type rocker arms. The valve guides are integral in the cylinder head.

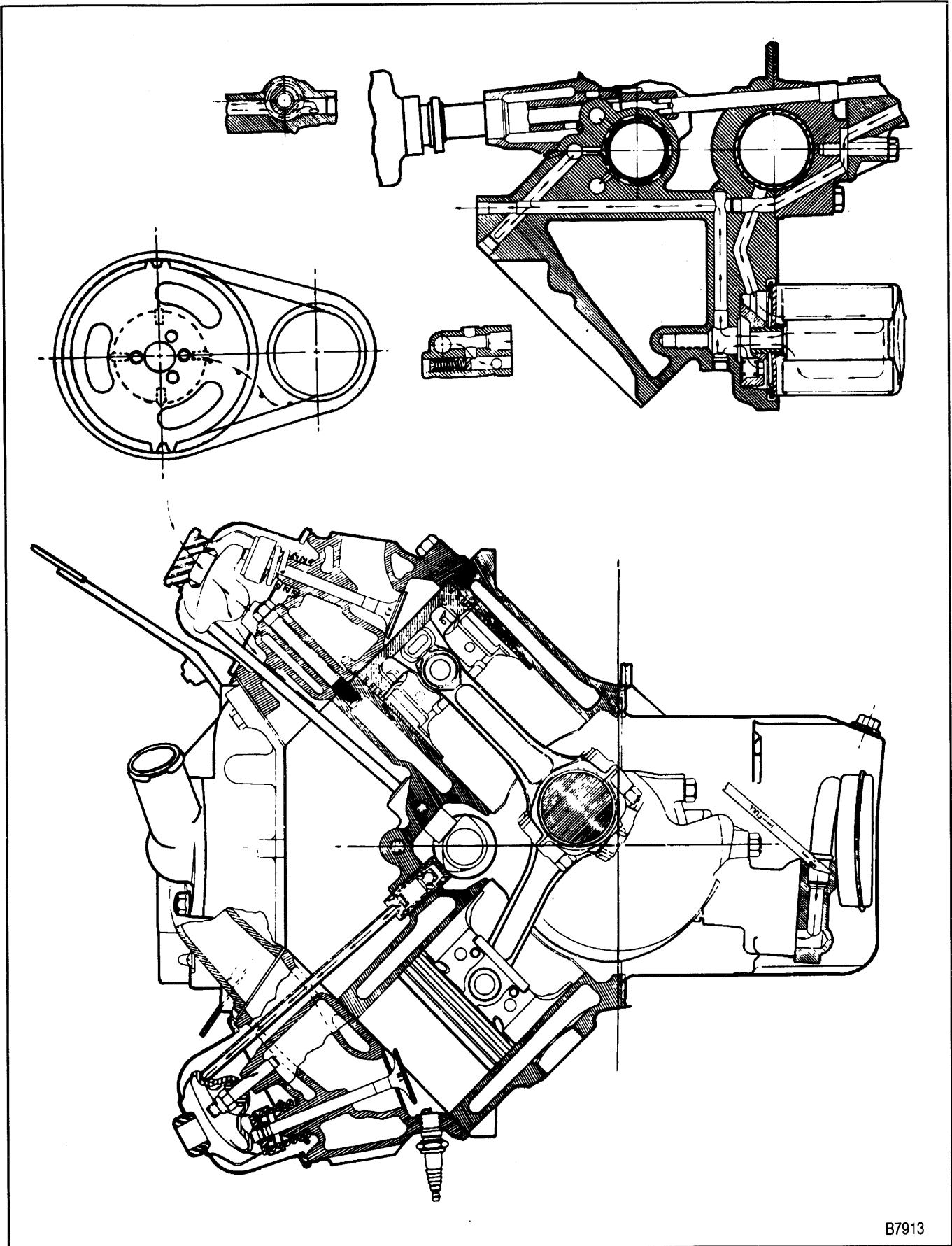
The pistons are cast aluminum alloy and the connecting rods are forged steel with precision insert type crankpin bearings. The piston pins are a press fit in the connecting rods and a floating fit in the piston.

ENGINE LUBRICATION

Lubrication schematics are shown in figures 5 and 6. The gear type oil pump is driven from the distributor shaft, which is gear driven from the camshaft. Oil is drawn into the oil pump through a pickup screen and pipe.

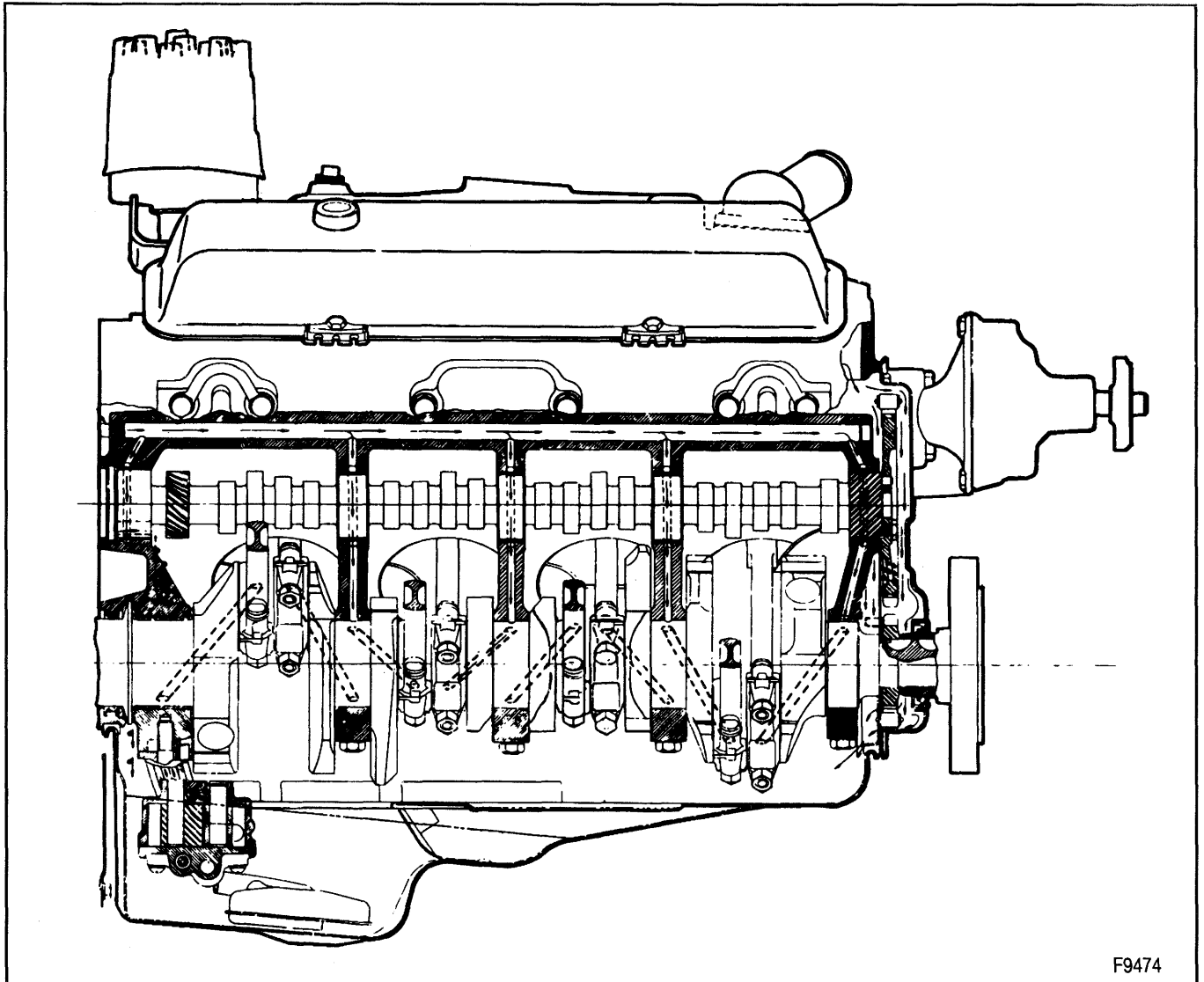
Pressurized oil is routed to the oil filter. In case of excessive oil pressure, a bypass valve is provided. Filtered oil flows into the main gallery and then to the camshaft and crankshaft bearings. The valve lifter oil gallery supplies oil to the valve lifters. Oil flows from the hydraulic lifters through the hollow pushrods to the rocker arms. Oil from overhead drains back to the crankcase through oil drain holes.

The timing chain is drip fed from the front camshaft bearing. The pistons and piston pins are lubricated by oil splash.



B7913

Figure 5—Engine Lubrication Diagram



F9474

Figure 6—Engine Lubrication Diagram

ON-VEHICLE SERVICE

ROCKER ARM COVER REPLACEMENT



Remove or Disconnect (Figure 7)

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
3. Crankcase ventilation hoses at the rocker arm covers.
4. Wiring harnesses from the clips, and move aside.
5. Components as follows for right rocker arm cover:
 - PCV valve.
 - Upper dipstick bracket.
 - Heat stove pipe.
 - Emissions sensors with bracket, and move aside.
6. Components as follows for left rocker arm cover:
 - Generator rear brace.
 - Crankcase ventilation pipe.
 - Power brake vacuum pipe and move aside.

7. Rocker arm cover bolts (5).
8. Rocker arm cover (7) and gasket (8).



Clean

- All traces of old gasket from the rocker arm cover and cylinder head.



Inspect

- Rocker arm cover sealing surface for distortion. Replace if necessary.



Install or Connect (Figure 7)

1. Rocker arm cover (7) and new gasket (8).

NOTICE: Refer to "Notice" on page 6A4-1.

2. Rocker arm cover bolts (5).

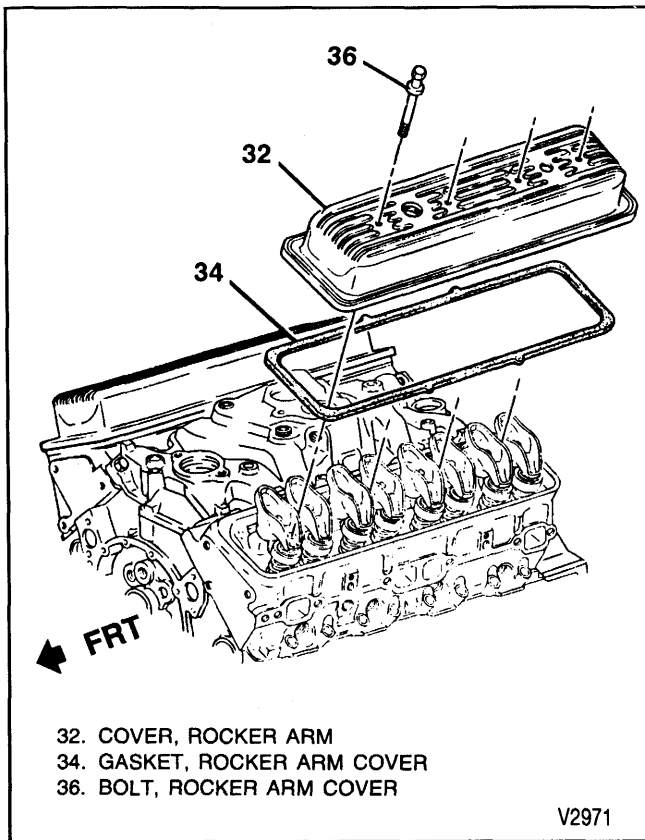


Figure 7—Rocker Arm Cover



Tighten

- Bolts (5) to 11 N·m (100 lbs. in.).

3. Components as follows for left rocker arm cover:

- Power brake vacuum pipe.
- Crankcase ventilation pipe.
- Generator rear brace.

4. Components as follows for right rocker arm cover:

- Emissions sensors with bracket.
- Heat stove pipe.
- Upper dipstick bracket.
- PCV valve.

5. Wiring harnesses to the rocker arm clips.

6. Crankcase ventilation hoses.

7. Air cleaner.

8. Negative battery cable.

ROCKER ARM AND PUSHROD REPLACEMENT



Remove or Disconnect

1. Rocker arm cover, as outlined previously.

2. Rocker arm nut.

- If only the pushrod is to be replaced, back the rocker arm nut off until the rocker arm can be swung away from the pushrod. Then pull the pushrod out.

3. Rocker arm with ball.

4. Pushrod.



Important

- Store used components in order so they can be reassembled in the same location.



Inspect

- Rocker arms and balls at their mating surfaces. These surfaces should be smooth and free from scoring or other damage.
- Rocker arm areas that contact the valve stems and the sockets that contact the pushrods. These areas should be smooth and free of damage and wear.
- Pushrods for bending. Roll the pushrod on a flat surface to determine if it is bent. Replace if necessary.
- Ends of the pushrods for scoring or roughness.



Install or Connect

1. Pushrod. Make sure the pushrod seats properly in the hydraulic lifter.

2. Rocker arm with ball.



Important

- When new rocker arms and/or balls are installed, coat their bearing surfaces with high viscosity oil with zinc (GM P/N 12345501) or equivalent.

3. Rocker arm nut.



Adjust

- Valves as outlined later in this section.

4. Rocker arm cover, as outlined previously.

VALVE ADJUSTMENT

1. Remove the rocker arm cover as outlined previously.

2. Crank the engine until the mark on the vibration damper lines up with the "0" mark on the timing tab and the engine in the number one firing position. This may be determined by placing fingers on

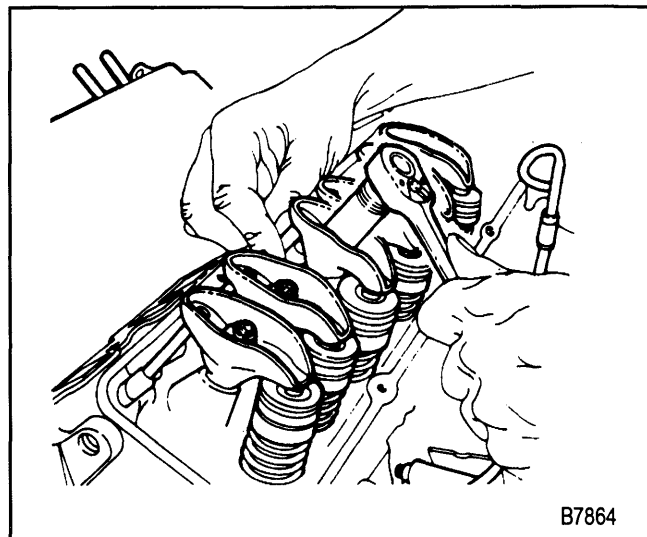


Figure 8—Adjusting the Valves

the number one valve as the mark on the damper comes near the "0" mark on the timing tab. If the rocker arms are not moving, the engine is in the number one firing position. If the rocker arms move as the mark comes up to the timing tab, the engine is in the number six firing position and should be turned over one more time to reach the number one position.

3. With the engine in the number one firing position as determined above, the following valves may be adjusted:

- Exhaust: 1, 3, 4, 8
- Intake: 1, 2, 5, 7

(Even numbered cylinders are in the left bank; odd numbered cylinders are in the right bank, when viewed from the front of the engine).

4. Back out the adjusting nut until lash is felt at the pushrod then turn in the adjusting nut until all lash is removed. This can be determined by rotating the pushrod while turning the adjusting nut (figure 8). When the play has been removed, turn the adjusting nut in one full additional turn (to center the lifter plunger).
5. Crank the engine one revolution until the timing tab "0" mark and vibration damper mark are again in alignment. This is the number six firing position the following valves may be adjusted:

- Exhaust: 2, 5, 6, 7
- Intake: 3, 4, 6, 8

6. Install the rocker arm cover as outlined previously.

VALVE STEM SEAL AND VALVE SPRING REPLACEMENT

↔ Remove or Disconnect (Figures 9 and 10)

Tools Required:

- J 23590 Air Adapter
- J 5892-C Spring Compressor

1. Rocker arm cover, as outlined previously.
2. Rocker arms, as outlined previously.
3. Spark plugs.

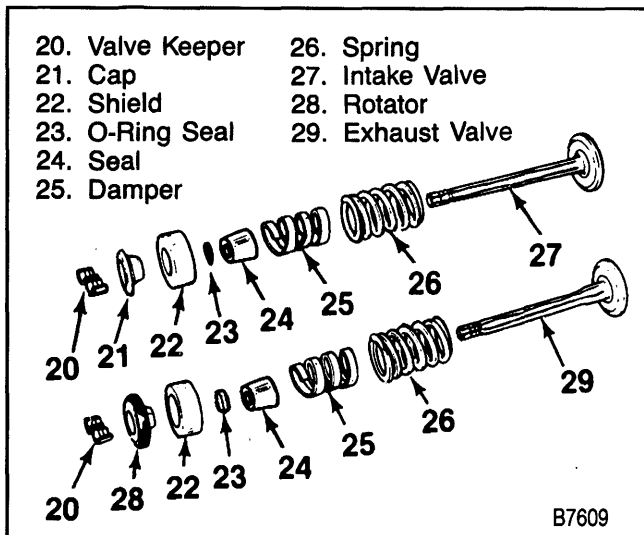


Figure 9—Valves and Components

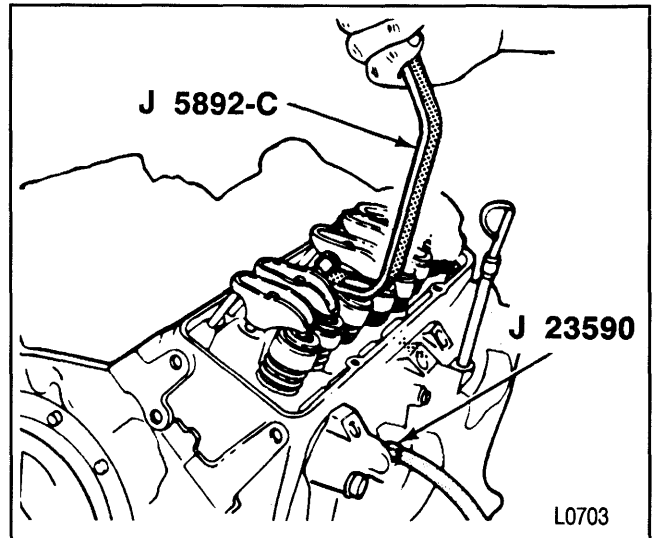


Figure 10—Compressing the Valve Spring

4. Valve keepers (20).

- A. Install J 23590 into the spark plug hole.
- B. Apply compressed air to hold the valves in place.
- C. Install a rocker arm nut (figure 10).
- D. Use J 5892-C to compress the valve spring (figure 10).
- E. Remove the valve keepers.
- F. Carefully relieve the spring tension. Remove J 5892-C.

5. Cap (21) and/or rotator (28), shield (22), and spring (26) with damper (25).
6. O-ring seal (23).
7. Seal (24).

→ Install or Connect (Figures 9, 10, and 11)

Tools Required:

- J 23590 Air Adapter
- J 5892-C Spring Compressor
- J 23738-A Vacuum Pump

1. New seal (24). Install the seal over the valve stem and seat it against the head.
2. Spring (26) with damper (25), shield (22), and cap (21) and/or rotator (28).
3. New O-ring seal (23) and valve keepers (20).

- A. With air pressure applied to the cylinder with J 23590, compress the spring with J 5892-C (figure 10).
- B. Lubricate the O-ring seal with engine oil. Install the seal on the valve stem. Make sure the seal is not twisted.
- C. Install the valve keepers. Use grease to hold them in place.
- D. Carefully release spring pressure. Make sure the valve keepers stay in place.
- E. Remove J 5892-C and J 23590.
- F. Check each O-ring seal for leakage (figure 11).

- a. Place the suction cup furnished with J 23738-A over the shield.

- b. Connect J 23738-A to the suction cup and apply a vacuum. Watch the vacuum pump gage. No air should be able to leak past the seal. If the seal will not hold a vacuum, it may have been damaged or improperly installed.

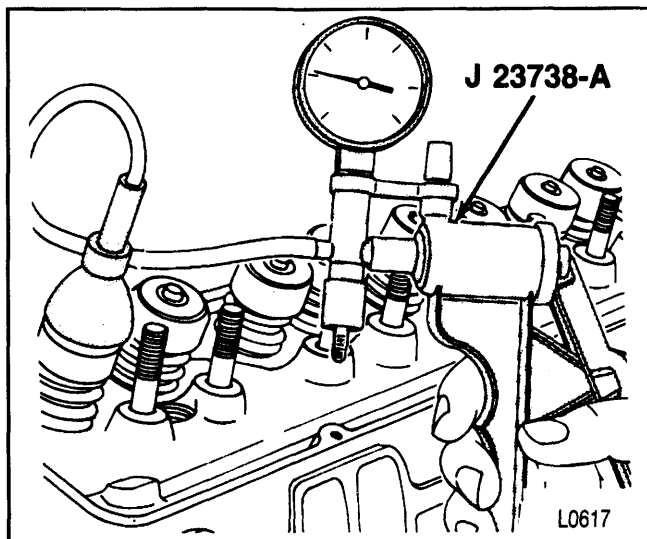
4. Spark plugs.
5. Rocker arms, as outlined previously.

**Adjust**

- Valves, as outlined previously.
6. Rocker arm cover, as outlined previously.

INTAKE MANIFOLD REPLACEMENT**Remove or Disconnect (Figure 12)**

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
 - Drain the cooling system.
3. Heater pipe and upper radiator hose at the intake manifold.
4. Generator rear brace at the manifold.
5. Vacuum hoses at the manifold, TBI unit, and EGR valve.
6. Electrical connections at the manifold and TBI unit.
7. Fuel lines at the TBI unit.
8. Accelerator and cruise control cables (if equipped).
9. Distributor. Refer to SECTION 6D4.
10. Air conditioning compressor rear bracket.
11. Brake booster vacuum pipe.
12. Coil wires.
13. Emission control sensors and bracket on right side.
14. Fuel line bracket at rear of manifold. Move the fuel lines aside.
15. Bracket at rear of belt idler pulley.
16. TBI unit (if necessary).
17. Intake manifold bolts.
18. Intake manifold.
19. Gaskets and clips.

**Figure 11—Testing the Valve Seals****Clean**

- Old gasket and RTV from the block, heads, and intake manifold. Remove all RTV that is loose or will cause interference at assembly.
- Excessive carbon deposits from the exhaust and EGR passages.
- Excessive scale and deposits from the coolant passages.

**Inspect**

- Manifold for cracks and gasket surface damage.

**Install or Connect (Figures 12 and 13)**

1. Gaskets to the cylinder head. Make sure the tab and/or arrow faces the front of the engine. The side stamped "This Side Down" must face the cylinder head.
2. RTV to the front and rear sealing surfaces on the block (figure 12). Apply a 5 mm (3/16-inch) bead of RTV (GM P/N 1052289 or equivalent) to the front and rear of the block as shown. Extend the bead 13 mm (1/2 inch) up each cylinder head to seal and retain the gaskets.
3. Intake manifold to the engine.

NOTICE: Refer to "Notice" on page 6A4-1.

4. Intake manifold bolts.

**Tighten**

- Intake manifold bolts to 48 N.m (35 lbs. ft.) using the tightening sequence shown in figure 13.
5. TBI unit (if removed).
 6. Bracket at rear of belt idler.
 7. Fuel line bracket at rear of manifold.
 8. Emission control sensors and bracket.
 9. Coil wires.
 10. Brake booster vacuum pipe.
 11. Air conditioning compressor rear bracket.
 12. Distributor. Refer to SECTION 6D4.
 13. Accelerator and cruise control cables (if equipped).
 14. Fuel lines to the TBI unit.
 15. Electrical connections.
 16. Vacuum hoses.
 17. Generator brace.
 18. Heater pipe and upper radiator hose.
 19. Air cleaner.
 20. Negative battery cable.
 - Fill the cooling system with the proper quantity and grade of coolant.

HYDRAULIC LIFTER REPLACEMENT**Remove or Disconnect (Figures 14 and 15)**

Tools Required:

- J 3049-A Hydraulic Lifter Remover (Plier Type)
- or
- J 9290-01 Hydraulic Lifter Remover (Slide Hammer Type)

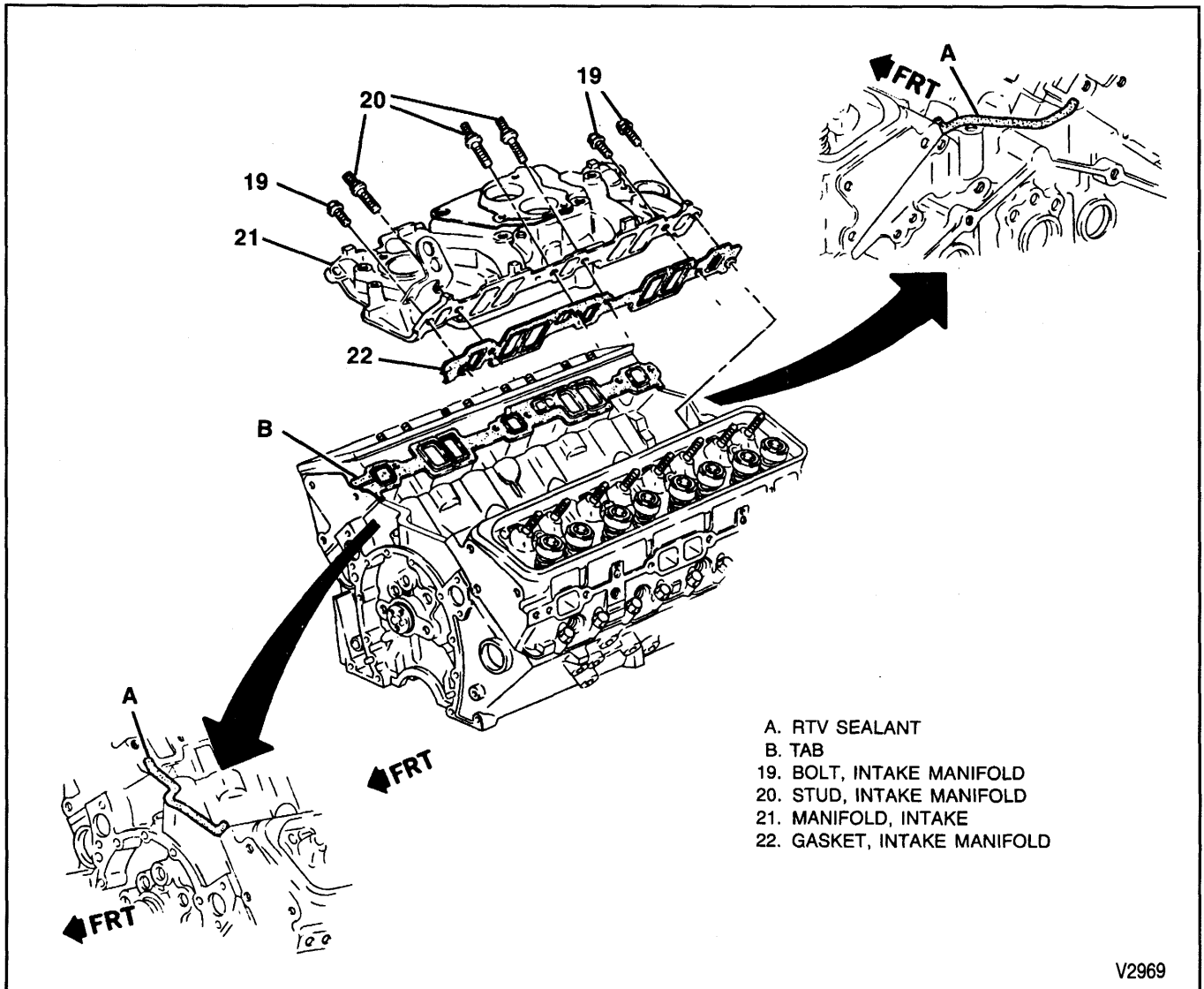


Figure 12—Intake Manifold

1. Rocker arm cover, intake manifold, and pushrod, as outlined previously.
2. Hydraulic lifters.
 - Remove the hydraulic lifters one at a time and place them in an organizer rack. The lifters must be installed in the same bore from which they were removed.

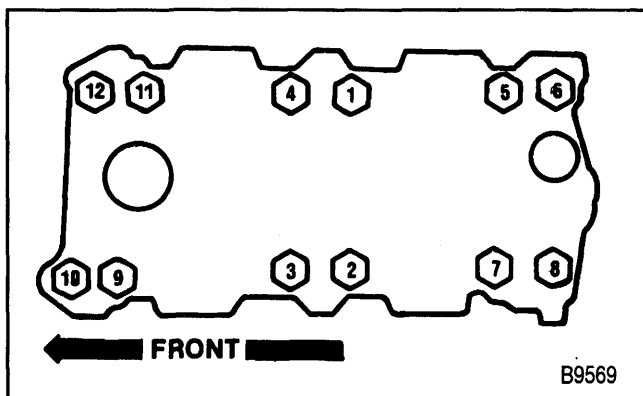


Figure 13—Intake Manifold Bolt Tightening Sequence

- A stuck hydraulic lifter can be removed using J 3049-A (figure 14) or J 9290-01 (figure 15).



Inspect

- Hydraulic lifter body for scuffing and scoring. If the lifter body wall is worn or damaged, the mating bore in the block should also be checked.
- Check the fit of each hydraulic lifter in its mating bore in the block. If the clearance is excessive, try a new lifter.
- The hydraulic lifter foot must be smooth and slightly convex. If worn, pitted, or damaged, the mating camshaft lobe should also be checked.

HYDRAULIC LIFTER REPAIR

- Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual.



Install or Connect

1. Hydraulic lifters to the block. Lubricate the lifter foot and body with High Viscosity Oil with Zinc (GM P/N 12345501) or equivalent.

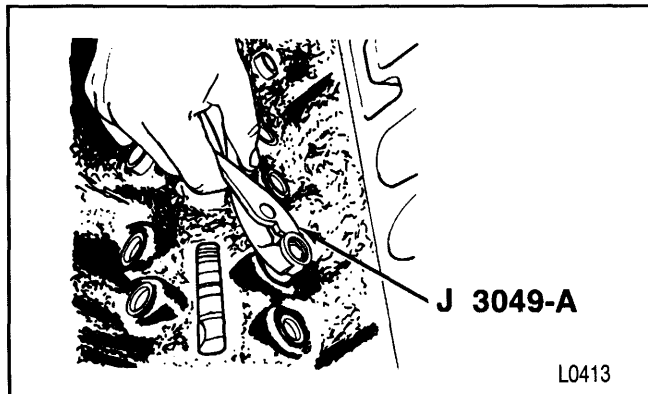


Figure 14—Removing the Hydraulic lifter

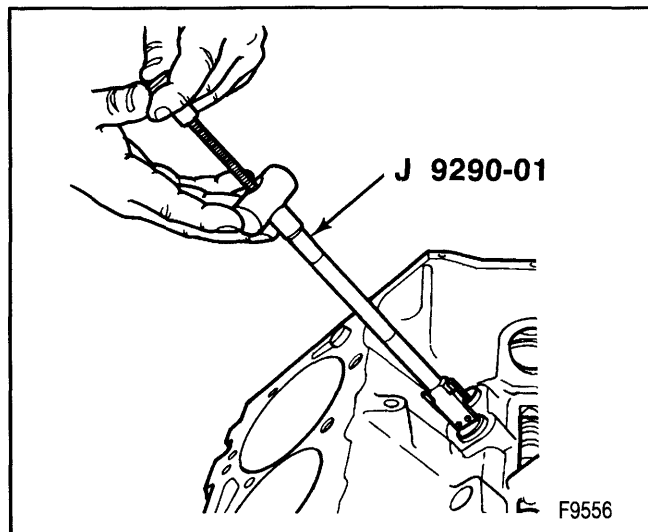


Figure 15—Removing the Hydraulic Lifter

! Important

- When any new hydraulic lifters or a new camshaft is installed, change the engine oil and filter. High viscosity oil with zinc (GM P/N 12345501) or equivalent should be added to the crankcase oil.
- Replace all hydraulic lifters when a new camshaft is installed.

2. Intake manifold, as outlined previously.
3. Pushrod, as outlined previously.

🔑 Adjust

- Valves, as outlined previously.
4. Rocker arm cover, as outlined previously.

ROCKER ARM STUD REPLACEMENT

↔ Remove or Disconnect (Figure 16)

Tool Required:

J 5802-01 Rocker Arm Stud Remover

1. Rocker arm cover and rocker arm, as outlined previously.
2. Rocker arm stud.

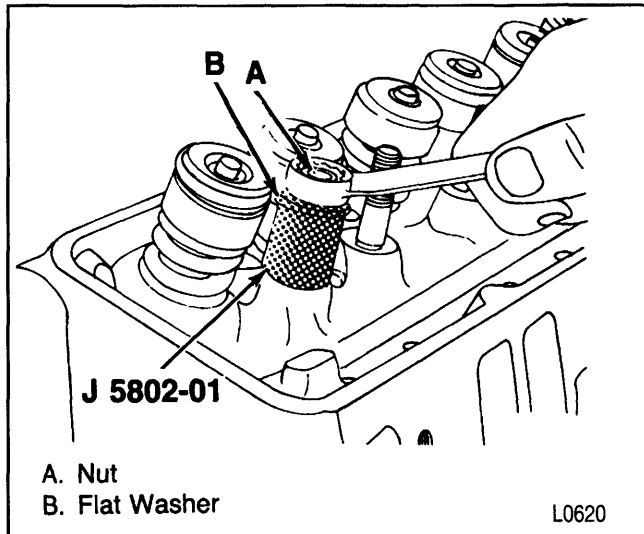


Figure 16—Removing the Rocker Arm Stud

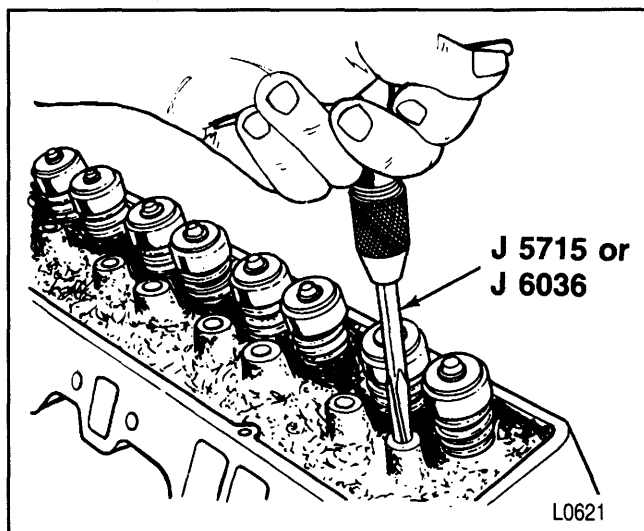


Figure 17—Reaming the Rocker Arm Stud Bore

- A. Place J 5802-01 over the rocker arm stud.
- B. Install a nut and flat washer.
- C. Turn the nut to remove the stud (figure 16).

↔ Install or Connect (Figures 17 and 18)

Tools Required:

- J 5715 Reamer (0.003-inch oversize) or
- J 6036 Reamer (0.013-inch oversize)
- J 6880 Rocker Arm Stud Installer

NOTICE: Do not attempt to install an oversize rocker arm stud without reaming stud hole as this could damage the cylinder head.

- Ream the hole to the proper size for the replacement oversize rocker arm stud. Use J 5715 for 0.003-inch oversize studs; J 6036 for 0.013-inch oversize studs (figure 17).
- Coat lower end (press-fit area) of rocker arm stud with hypoid axle lubricant.

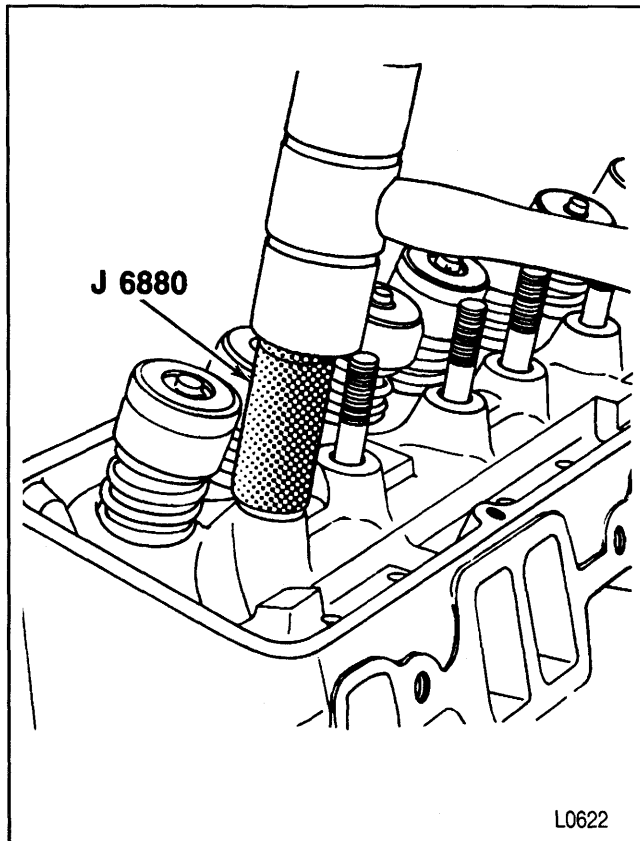


Figure 18—Installing the Rocker Arm Stud

1. Rocker arm stud. Use J 6880 (figure 18). Stud is installed to proper depth when the tool bottoms on the cylinder head.
2. Rocker arm, as outlined previously.



Adjust

- Valves, as outlined previously.
3. Rocker arm cover, as outlined previously.

EXHAUST MANIFOLD REPLACEMENT



Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle. Support with safety stands.
2. Exhaust pipe at the manifold.
 - Lower the vehicle.
3. Oxygen sensor wire (left side manifold). Do not remove the oxygen sensor unless replacement is required.
4. AIR hose at the check valve.
5. Heat stove pipe (right side manifold).
6. Power steering pump rear bracket at the manifold (left side manifold).
7. Dipstick tube bracket (right side manifold).
8. Exhaust manifold bolts, washers, and tab washers.
9. Exhaust manifold.



Clean

- Mating surfaces on the manifold and head.
- Threads on the exhaust manifold bolts.



Install or Connect

1. Exhaust manifold to the cylinder head.

NOTICE: Refer to "Notice" on page 6A4-1.

2. Exhaust manifold fasteners. Install the flat washers against the manifold, then the tab washers and bolts.



Tighten

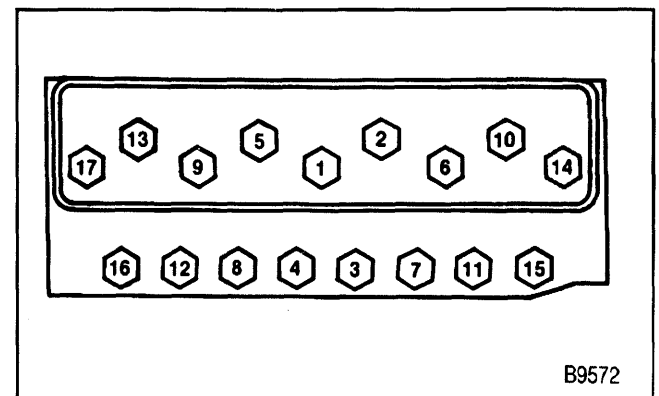
- Two center bolts to 36 N·m (26 lbs. ft.).
 - Outside bolts to 28 N·m (20 lbs. ft.).
 - Bend the tab washers against the bolt heads.
3. Power steering pump rear bracket at the manifold (left side manifold).
 4. Dipstick tube bracket (right side manifold).
 5. Heat stove pipe (right side manifold).
 6. AIR hose at the check valve.
 7. Oxygen sensor wire.
 - Raise the vehicle. Support with safety stands.
 8. Exhaust pipe.
 - Lower the vehicle.
 9. Negative battery cable.

CYLINDER HEAD REPLACEMENT



Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
 - Drain the cooling system.
2. Intake manifold, as outlined previously.
3. Exhaust manifold, as outlined previously.
4. Ground strap at rear of cylinder head (right side cylinder head).
5. AIR pipe at the rear of the cylinder head.
6. Components as follows for right side cylinder head.
 - AIR pump bolt and spacer at the cylinder head.
 - Nut and stud attaching air conditioning compressor to cylinder head.



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Figure 19—Cylinder Head Tightening Sequence

6A4-14 5.0L AND 5.7L V8

- Fuel pipe, plug wire, and wiring harness brackets at the rear of the cylinder head.
7. Components as follows for left side cylinder head:
 - Nut and stud attaching main accessory bracket to the cylinder head. It may be necessary to loosen the remaining bolts and studs and move the bracket forward slightly for clearance to remove the cylinder head.
 - Coolant sensor wire.
 - Spark plug wire brackets at the rear of the cylinder head.
 8. Rocker arm cover, as outlined previously.
 9. Spark plugs.
 10. Pushrods, as outlined previously.
 11. Cylinder head bolts.
 12. Cylinder head.
 13. Head gasket.



Clean

- Carbon deposits from combustion chambers.
- All traces of old head gasket from cylinder head and block.
- Cylinder head bolt threads and threads in the block.



Inspect

- Sealing surfaces of the block and cylinder head for nicks, heavy scratches, or other damage.

CYLINDER HEAD REPAIR

- Refer to Section 6A of the Light Duty Truck Unit Repair Manual.



Install or Connect (Figure 19)

1. Head gasket.
 - Do not use sealer on composition steel-asbestos gaskets.
 - Place the gasket over the block dowel pins with the bead up.
2. Cylinder head. Carefully guide the cylinder head into place over the dowel pins and gasket.

NOTICE: Refer to "Notice" on page 6A4-1.

3. Cylinder head bolts. Coat threads of the cylinder head bolts with sealing compound (GM P/N 1052080 or equivalent) and install finger-tight.



Tighten

- Bolts in three steps using the sequence shown in figure 19 until the proper torque is reached:
 - The first sequence to 35 N.m (25 lbs. ft.).
 - The second sequence to 60 N.m (45 ft. lbs.).
 - The final torque sequence to 90 N.m (65 lbs. ft.).
4. Pushrods, as outlined previously.



Adjust

- Valves, as outlined previously.
5. Rocker arm cover, as outlined previously.
 6. Spark plugs.

7. Components as follows for right side cylinder head:
 - AIR pump bolt and spacer at the cylinder head.
 - Nut and stud attaching the air conditioning compressor to the cylinder head.
 - Fuel pipe, plug wire, and wiring harness brackets at the rear of the cylinder head.
8. Components as follows for left side cylinder head:
 - Nut and stud attaching main accessory bracket to the cylinder head.
 - Remaining main accessory bracket bolts and nuts, if necessary.
 - Coolant sensor wire.
 - Spark plug wire brackets at the rear of the cylinder head.
9. AIR pipe.
10. Ground strap at the rear of the cylinder head (right side cylinder head).
11. Exhaust manifold, as outlined previously.
12. Intake manifold, as outlined previously.
13. Negative battery cable.
 - Fill the cooling system with the proper quantity and grade of coolant. Refer to SECTION 0B.

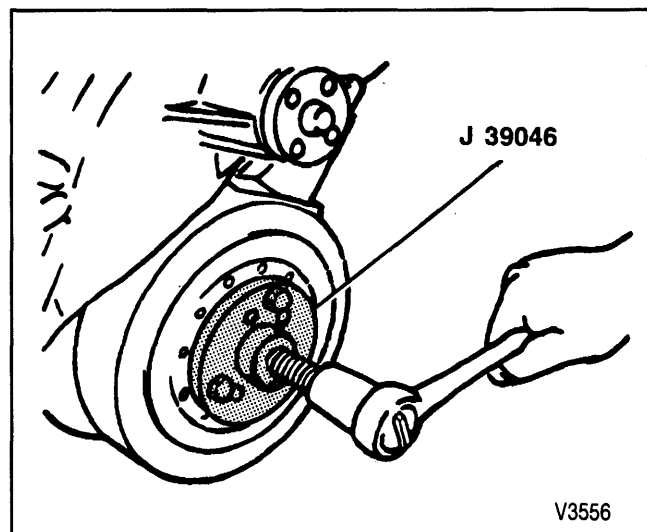


Figure 20—Removing the Torsional Damper

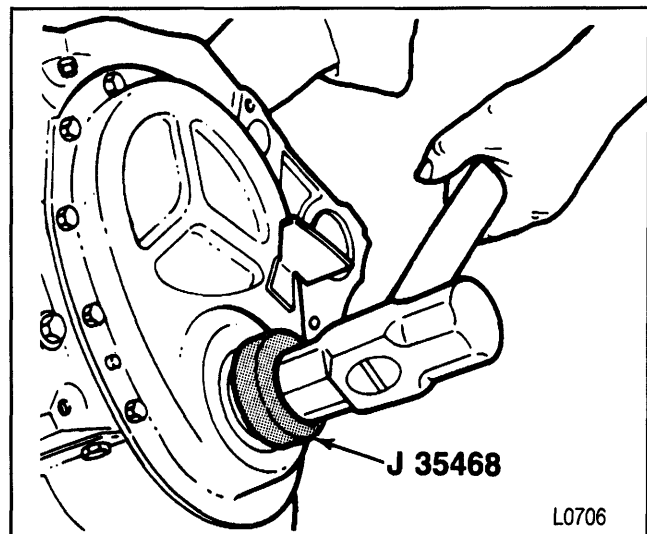


Figure 21—Installing the Crankshaft Front Oil Seal

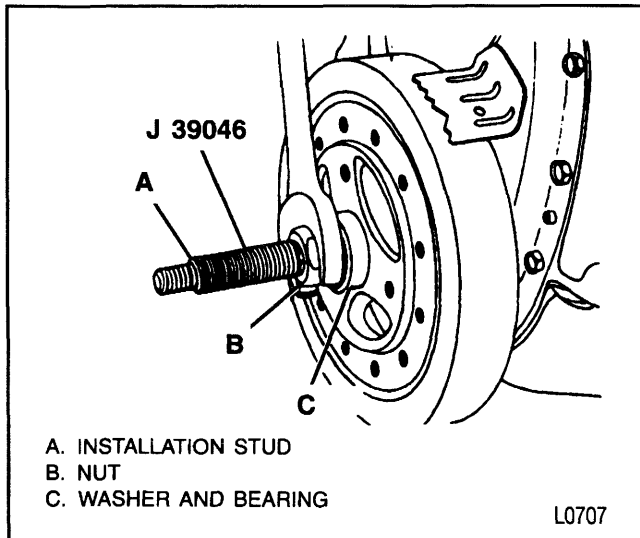


Figure 22—Installing the Torsional Damper

TORSIONAL DAMPER AND CRANKSHAFT FRONT SEAL REPLACEMENT

Remove or Disconnect (Figure 20)

Tool Required:

J 39046 Torsional Damper Puller and Installer

1. Multiple ribbed belt, fan, and pulley.
2. Fan shroud assembly.
3. Accessory drive pulley.
4. Torsional damper bolt.
5. Torsional damper. Use J 39046 (figure 20).
6. Crankshaft front seal. Pry out with a large screwdriver. Take care not to distort the timing cover.
7. Crankshaft key, if necessary.

Inspect

- Oil seal contact area on the torsional damper shaft for grooving and roughness. Replace if necessary.

Install or Connect (Figures 21 and 22)

Tools Required:

J 35468 Seal Installer

J 39046 Torsional Damper Puller and Installer

1. Crankshaft key, if removed.
2. Crankshaft front seal. Use J 35468 (figure 21). The open end of the seal faces inside the engine. Coat the seal lips with engine oil.

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber-type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the torsional damper.

3. Stud (item A, figure 22) to the crankshaft. Thread the stud fully into the tapped hole in the crankshaft.

4. Torsional damper over the end of the stud. Align the keyway in the torsional damper shaft with the crankshaft key.
 - Use a small amount of RTV sealant to seal the torsional damper key to crankshaft joint.
5. Bearing, washer and nut (figure 22).
 - Turn the nut to pull the vibration damper into place.
 - Remove the tool.

NOTICE: Refer to "Notice" on page 6A4-1.

6. Torsional damper bolt and washer.



Tighten

- Bolt to 95 N.m (70 lbs. ft.).
7. Accessory drive pulley.
 8. Fan shroud assembly.
 9. Fan pulley, fan, and multiple ribbed belt.

FRONT COVER REPLACEMENT



Remove or Disconnect

1. Torsional damper, as outlined previously.
2. Coolant pump.
3. Oil pan, as outlined later in this section.
4. Front cover bolts.
5. Front cover.
6. Front cover to block gasket.
7. Crankshaft front seal from the front cover. Pry out with a screwdriver. Take care not to distort the front cover.



Clean

- Old gasket from the front cover and block.



Inspect

- Front cover for distortion and damage. Replace if necessary.



Install or Connect (Figure 21)

Tools Required:

J 35468 Seal Installer

1. Crankshaft front seal. Use J 35468 (figure 21). The open end of the seal faces inside the engine. Coat the seal lips with engine oil.
2. Front cover gasket to the front cover. Use gasket cement to hold it in place.

NOTICE: Refer to "Notice" on page 6A4-1.

3. Front cover and bolts to the engine.



Tighten

- Front cover to block bolts to 11 N.m (100 lbs. in.).
4. Oil pan, as outlined later in this section.
 5. Coolant pump. Refer to SECTION 6B1.
 6. Torsional damper, as outlined previously.

OIL PAN REPLACEMENT

A one-piece type oil pan gasket is used.

C-MODELS

 Remove or Disconnect (Figure 23)

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle. Support with safety stands.
 - Drain the engine oil.
2. Exhaust crossover pipe.
3. Flywheel/torque converter cover.
4. Strut rods at the engine mountings (if used).
5. Oil pan bolts, nuts, and reinforcements.
6. Oil pan and gasket.

 Clean

- Gasket surfaces on the engine and oil pan.

 Inspect

- Oil pan gasket for damage. Replace if necessary.

 Install or Connect (Figure 23)

- Apply sealant (GM P/N 1052080 or equivalent) to the front cover to block joint and to the rear crankshaft seal to block joint. Apply the sealant for about 25 mm (1 inch) in both directions from each of the four corners.

1. Oil pan gasket to the oil pan.
2. Oil pan to the engine.

NOTICE: Refer to "Notice" on page 6A4-1.

3. Oil pan bolts, nuts, and reinforcements.

 Tighten

- Oil pan bolts to 11 N.m (100 lbs. in.).
 - Oil pan nuts to 22 N.m (16 lbs. ft.).
4. Strut rods at the engine mount (if used).
 5. Flywheel/torque converter cover.
 6. Exhaust crossover pipe.
 - Lower the vehicle.
 7. Proper quantity and grade of engine oil. Refer to SECTION 0B.
 8. Negative battery cable.

K-MODELS

 Remove or Disconnect (Figure 23)

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle. Support with safety stands.
 - Drain the engine oil.
2. Front shield (to gain access to axle bolts).
3. Front skid plate (if equipped).
4. Front propeller shaft at front axle. Refer to SECTION 4A.
 - Support front axle.
5. Front axle mounting bolts.
6. Front axle from mounting brackets.

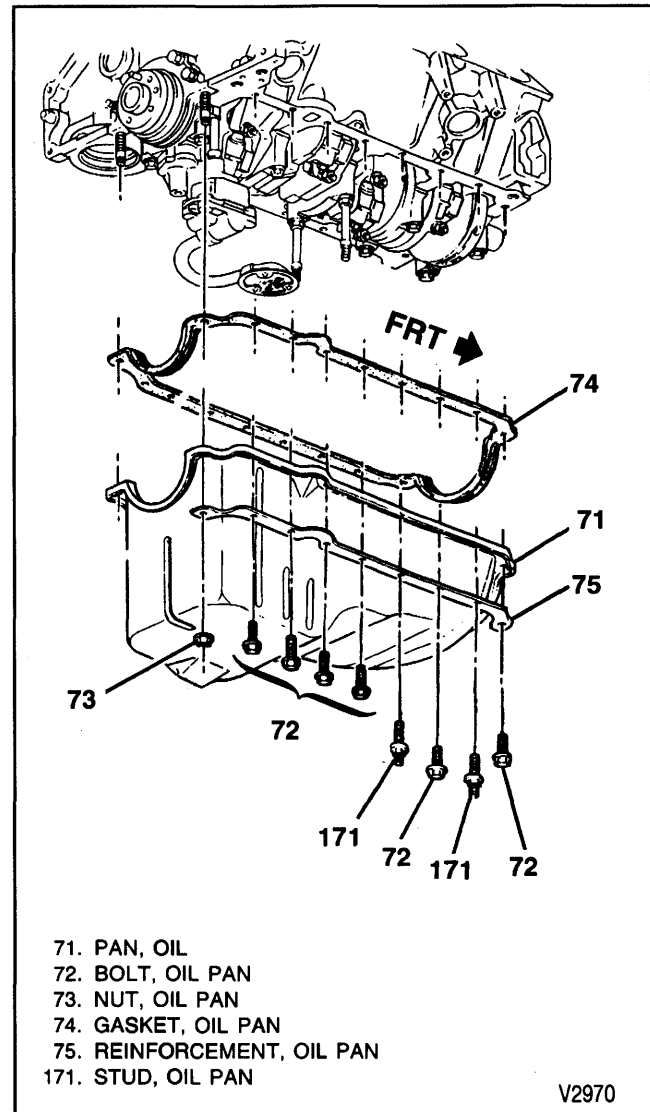


Figure 23—Oil Pan and Components

- Rotate front axle downward to gain access to the oil pan.
7. Strut rods at inspection cover.
 8. Exhaust crossover pipe at exhaust manifolds.
 9. Starter (wire it aside).
 10. Transmission fluid cooler lines (if equipped) from transmission. Refer to SECTION 7.
 11. Flywheel/torque converter inspection cover.
 12. Oil cooler line bracket (if equipped).
 13. Oil filter and adapter.
 - Loosen transmission mount bolts at transmission crossmember. Refer to SECTION 7.
 - Raise the transmission/engine assembly (at the transmission) enough to allow the oil pan to clear the flexplate.
 14. Oil pan bolts, nuts, and reinforcements.
 15. Oil pan and gasket.

 Clean

- Gasket surfaces on the engine and oil pan.

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Inspect

- Oil pan gasket for damage. Replace if necessary.

Install or Connect (Figure 23)

- Apply sealant (GM P/N 1052080 or equivalent) to the front cover to block joint and to the rear crankshaft seal to block joint. Apply the sealant for about 25 mm (1 inch) in both directions from each of the four corners.
1. Oil pan gasket to the oil pan.
 2. Oil pan to the engine.

NOTICE: Refer to "Notice" on page 6A4-1.

3. Oil pan bolts, nuts, and reinforcements.

Tighten

- Oil pan bolts to 11 N.m (100 lbs. in.).
 - Oil pan nuts to 22 N.m (16 lbs. ft.).
 - Lower transmission/engine assembly back into transmission crossmember.
4. Transmission mount nuts. Refer to SECTION 7.
 5. Oil cooler line bracket (if equipped).
 6. Flywheel/torque converter inspection cover.
 7. Strut rods at the inspection cover.
 8. Starter motor. Refer to SECTION 6D2.
 9. Exhaust crossover pipe to exhaust manifolds.
 - Rotate the front axle back to its original position.
 10. Front axle to its mounting brackets.
 11. Front propeller shaft to front axle. Refer to SECTION 4A.
 12. Transmission fluid cooler lines to transmission. Refer to SECTION 7.
 13. Front skid plate (if equipped).
 14. Front shield.
 - Lower the vehicle.
 15. Proper quantity and grade of engine oil. Refer to SECTION 0B.
 16. Negative battery cable.

OIL PUMP REPLACEMENT

Remove or Disconnect

1. Oil pan, as outlined previously.
2. Oil pump bolt.
3. Oil pump.
 - Oil pump pickup tube for looseness. If the tube is loose in the oil pump body, replace it, as outlined in SECTION 6A5 of the Light Duty Truck Unit Repair Manual. A loose pickup tube can result in an air leak and loss of oil pressure.

OIL PUMP REPAIR

- Refer to SECTION 6A5 of the Light Duty Truck Unit Repair Manual.

Install or Connect

1. Oil pump to the engine. Align the slot in the oil pump shaft with the tang on the distributor shaft. The oil pump should slide easily into place. No gasket is used.

NOTICE: Refer to "Notice" on page 6A4-1.

2. Oil pump bolt.

Tighten

- Bolt to 90 N.m (65 lbs. ft.).
3. Oil pan, as outlined previously.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Remove or Disconnect (Figure 24)

1. Transmission.
2. Clutch and flywheel or flexplate, as equipped.

NOTICE: Take care when removing the rear crankshaft oil seal not to nick the crankshaft sealing surface.

3. Crankshaft rear oil seal. Insert a screwdriver into the notches provided in the seal retainer and pry the seal out (figure 24). Take care not to damage the crankshaft seal surface.

Inspect

- Chamfer on crankshaft for grit, loose rust, and burrs. Correct as necessary.

Clean

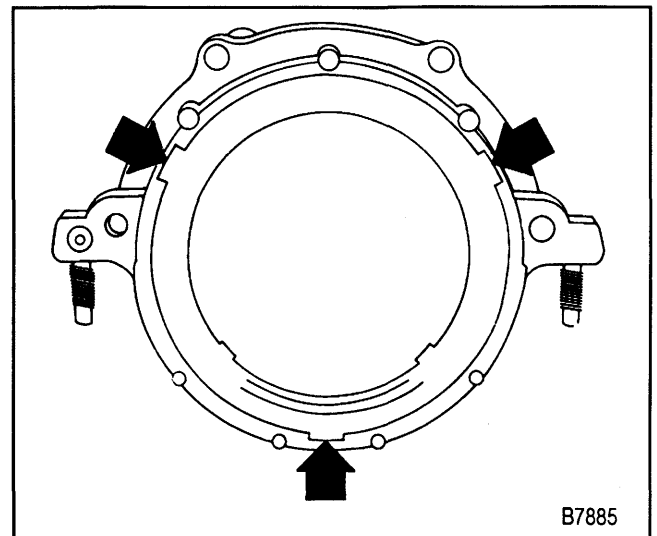
- Seal running surface on the crankshaft with a non-abrasive cleaner.

Install or Connect (Figure 25)

Tool Required:

J 35621 Seal Installer

1. Crankshaft rear oil seal (figure 25).
 - A. Lubricate the inner and outer diameter of the seal with engine oil.



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Figure 24—Seal Removal Notches

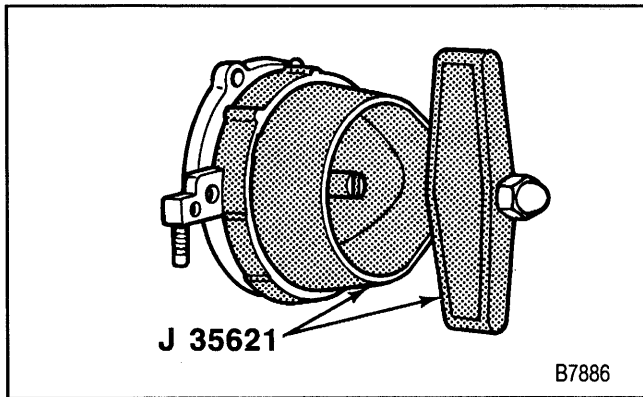


Figure 25—Installing the Crankshaft Rear Oil Seal

- B. Install the seal on J 35621.
 - C. Position J 35621 against the crankshaft. Thread the attaching screws into the tapped holes in the crankshaft.
 - D. Tighten the screws securely with a screwdriver. This will ensure that the seal is installed squarely over the crankshaft.
 - E. Turn the handle until it bottoms.
 - F. Remove J 35621.
2. Clutch and flywheel or flexplate, as equipped.
 3. Transmission.

CRANKSHAFT REAR OIL SEAL RETAINER REPLACEMENT

Remove or Disconnect (Figures 24 and 26)

1. Transmission.
2. Clutch and flywheel or flexplate, as equipped.
3. Oil pan, as outlined previously.
4. Screws (80) and nuts (81).
5. Seal retainer (82).
6. Gasket (84).
7. Crankshaft rear oil seal. Insert a screwdriver into the notches provided in the seal retainer and pry the seal out (figure 24).

Clean

- Gasket surfaces on block and seal retainer.

Install or Connect (Figure 26)

- Whenever the seal retainer is removed, a new retainer gasket and crankshaft rear oil seal must be installed.
 1. Gasket (84) to the block. It is not necessary to use sealant to hold the gasket in place.
 2. Seal retainer (82).

NOTICE: Refer to "Notice" on page 6A4-1.

3. Screws (80) and nuts (81).

Tighten

- Screws (80) and nuts (81) to 15 N·m (135 lbs. in.).
4. Oil pan, as outlined previously.
 5. Crankshaft rear oil seal as outlined previously.
 6. Clutch and flywheel or flexplate, as equipped.
 7. Transmission.

MEASURING CAMSHAFT LOBE LIFT

Tool Required:

J 8520 Camshaft Lobe Lift Indicator

1. Remove the rocker arm as outlined previously.
2. Refer to figure 27. Position the dial indicator (part of J 8520) so the plunger rests on the pushrod end, as shown. Make sure the pushrod is in the lifter socket.
3. Rotate the crankshaft slowly in the direction of normal rotation until the lifter is on the heel of the cam lobe. At this point, the pushrod will be in its lowest position.
4. Set dial indicator on zero, then rotate the crankshaft slowly, or attach an auxiliary starter switch and "bump" the engine over until the pushrod is in fully raised position.

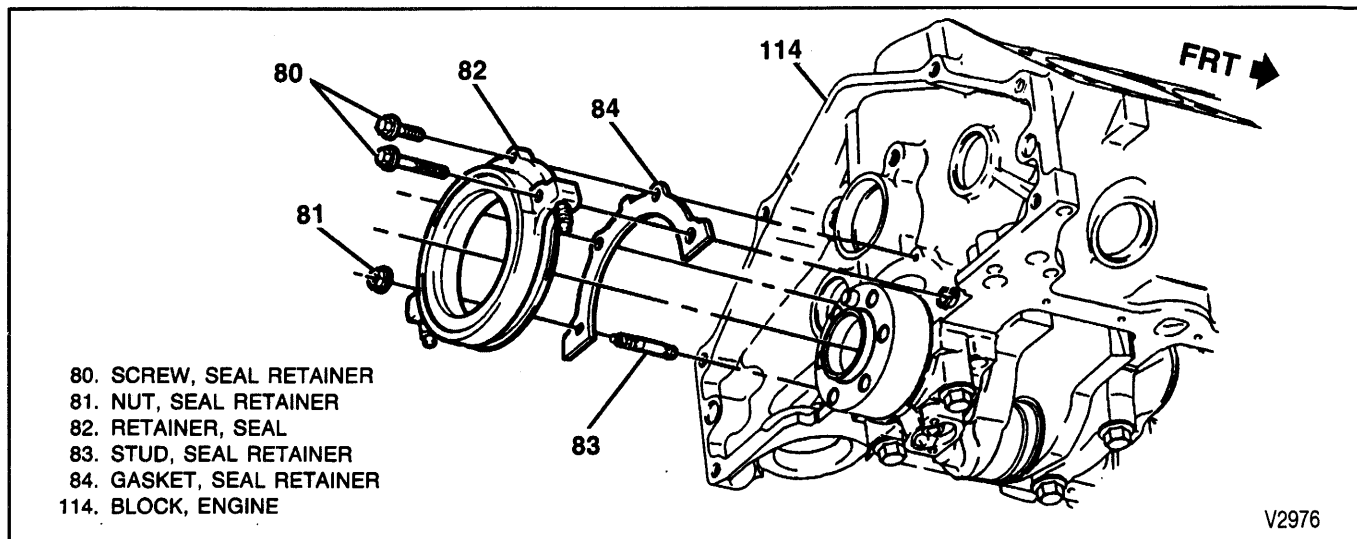


Figure 26—Crankshaft Rear Oil Seal Retainer

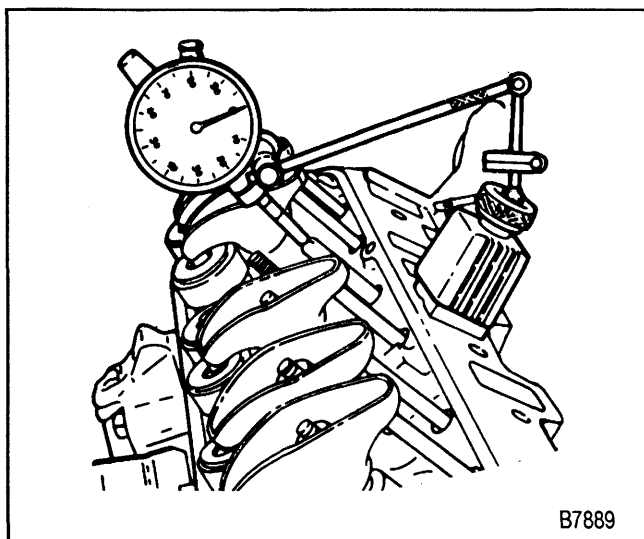


Figure 27—Measuring Camshaft Lobe Lift

! Important

- Whenever the engine is cranked remotely at the starter, with a special jumper cable or other means, the distributor primary lead or coil primary leads should be disconnected.
5. Compare the total lift recorded from the dial indicator with specifications.
 6. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
 7. Install the rocker arm and adjust the valves as outlined previously.

CAMSHAFT REPLACEMENT

- ↔ Remove or Disconnect (Figures 28, 29, and 30)

Tool Required:

J 5825-A Crankshaft Sprocket Puller

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
3. Fan, shroud, and radiator.
4. Rocker arm covers, as outlined previously.

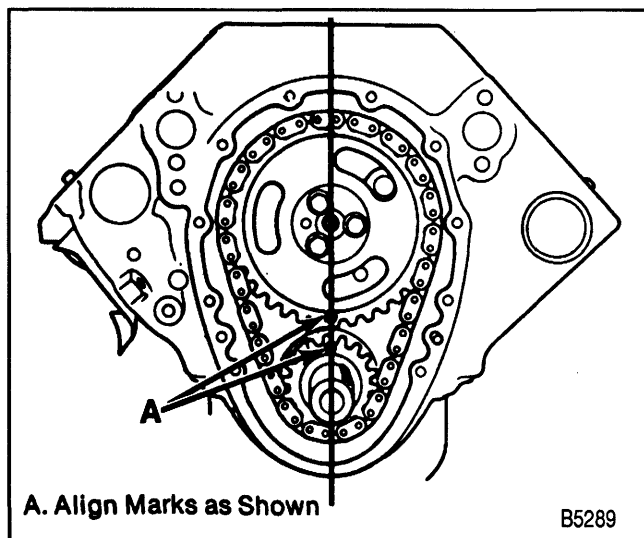


Figure 28—Timing Marks

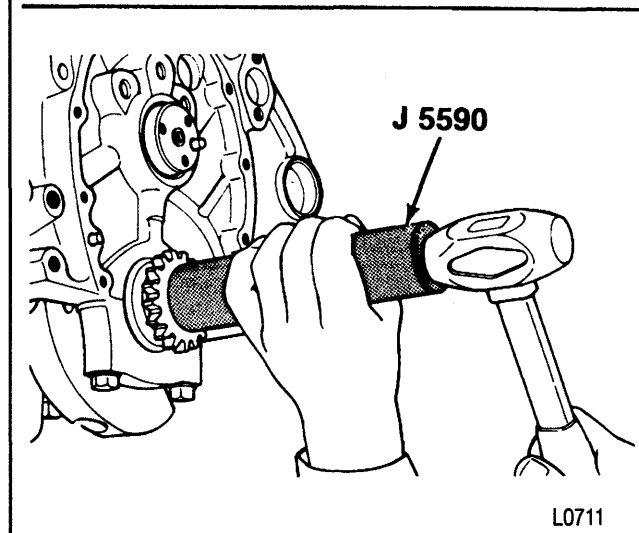
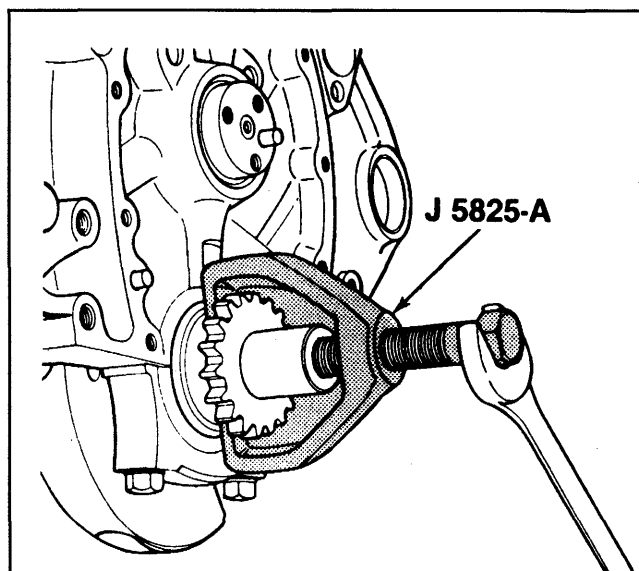


Figure 29—Replacing the Crankshaft Sprocket

5. Coolant pump.
6. Torsional damper, as outlined previously.
7. Front cover, as outlined previously.
8. Distributor. Refer to SECTION 6D4.
9. Intake manifold, as outlined previously.
10. Pushrods and hydraulic lifters, as outlined previously.
- Align the timing marks (figure 28).
11. Camshaft sprocket bolts.
12. Camshaft sprocket and timing chain. The sprocket is a light interference fit on the camshaft. Tap the sprocket on its lower edge to loosen it.
13. Crankshaft sprocket (if required). Use J 5825-A (figure 29).
14. Front engine mounting through bolts.

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

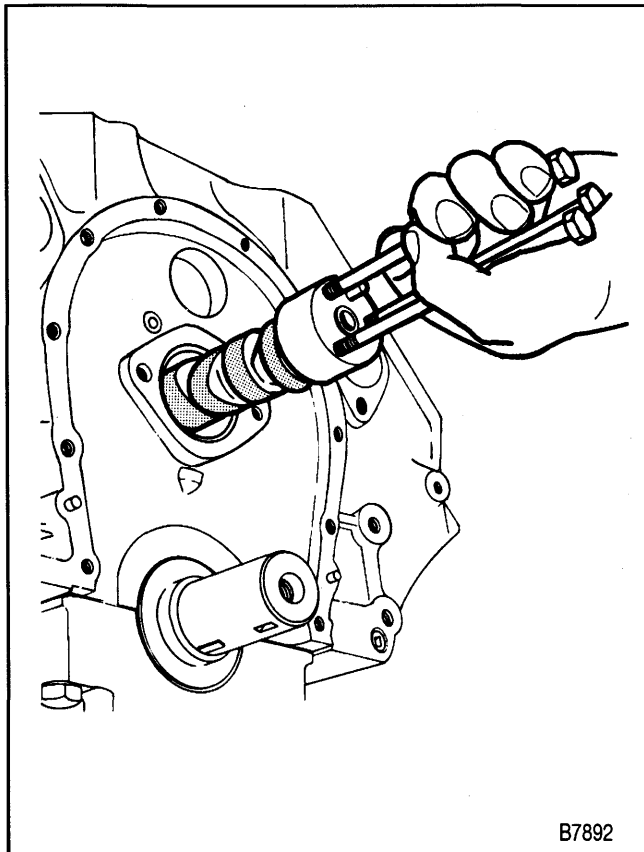


Figure 30—Replacing the Camshaft

- Raise the engine.
- 15. Camshaft
 - A. Install two or three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft threaded holes. Use these bolts to handle the camshaft (figure 30).
 - B. Pull the camshaft from the block. Use care to prevent damage to the camshaft bearings.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the camshaft and related components, as outlined in SECTION 6A5 of the Light Duty Truck Unit Repair Manual.

The Light Duty Truck Unit Repair Manual also describes camshaft bearing replacement.



Install or Connect (Figures 28 through 30 and 38)

NOTICE: For steps 3 and 6, refer to "Notice" on page 6A4-1.

Tool Required:

J 5590 Crankshaft Sprocket Installer

- Coat the camshaft lobes and journals with a high viscosity oil with zinc (GM P/N 12345501) or equivalent.
- 1. Two or three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft threaded holes. Use these bolts to handle the camshaft.
- 2. Camshaft to the engine (figure 30). Handle the camshaft carefully to prevent damage to the camshaft bearings.
- Lower the engine.

3. Engine mount through-bolts.



Tighten

- Through-bolts to specifications. Refer to figure 38.
- 4. Crankshaft sprocket (if removed). Use J 5590 (figure 29). Make sure the timing mark faces outside.
- 5. Camshaft sprocket and timing chain.



Important

- Line up the timing marks on the camshaft sprocket and crankshaft sprocket (figure 28).
- 6. Camshaft sprocket bolts.



Tighten

- Bolts to 24 N.m (18 lbs. ft.).
- 7. Hydraulic lifters and pushrods, as outlined previously.



Important

- Replace all hydraulic lifters, change the engine oil and filter, and add High Viscosity Oil with Zinc (GM P/N 12345501) or equivalent whenever a new camshaft is installed.



Adjust

- Valves, as outlined previously.
- 8. Intake manifold, as outlined previously.
- 9. Distributor. Refer to SECTION 6D4.
- 10. Front cover, as outlined previously.
- 11. Torsional damper, as outlined previously.
- 12. Coolant pump.
- 13. Rocker arm covers, as outlined previously.
- 14. Fan, shroud, and radiator.
- 15. Air cleaner.
- 16. Negative battery cable.
- Fill the cooling system with the proper quantity and grade of coolant. Refer to SECTION 0B.

CONNECTING ROD AND PISTON REPLACEMENT



Remove or Disconnect (Figure 31)

Tool Required:

J 5239 Guide Set

- 1. Cylinder head, as outlined previously.
- 2. Oil pan, as outlined previously.
- 3. Oil pump, as outlined previously.
- 4. Ridge or deposits from the upper end of the cylinder bores.
 - A. Turn the crankshaft until the piston is at BDC.
 - B. Place a cloth on top of the piston.
 - C. Perform the cutting operation with a ridge reamer.
 - D. Turn the crankshaft until the piston is at TDC.
 - E. Remove the cloth and cuttings.

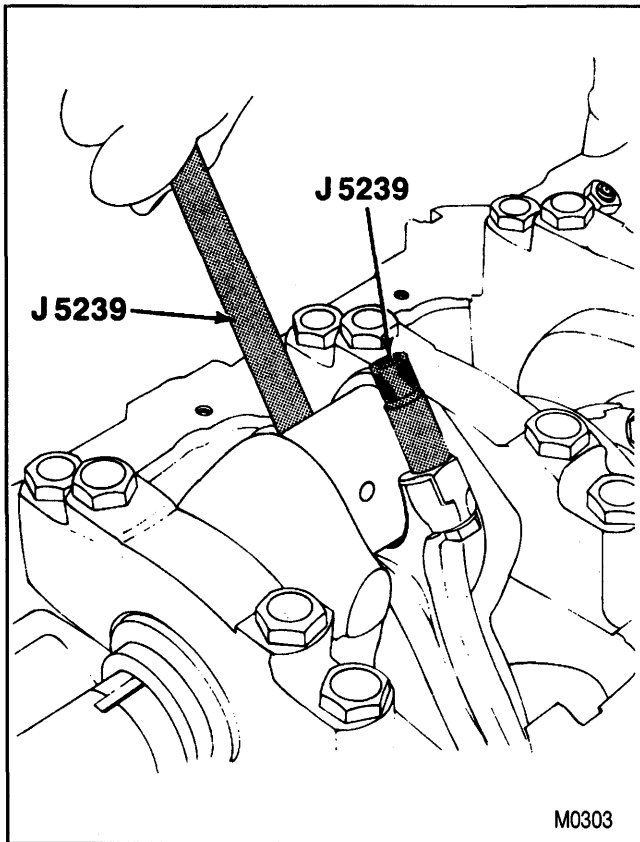


Figure 31—Replacing the Piston and Connecting Rod

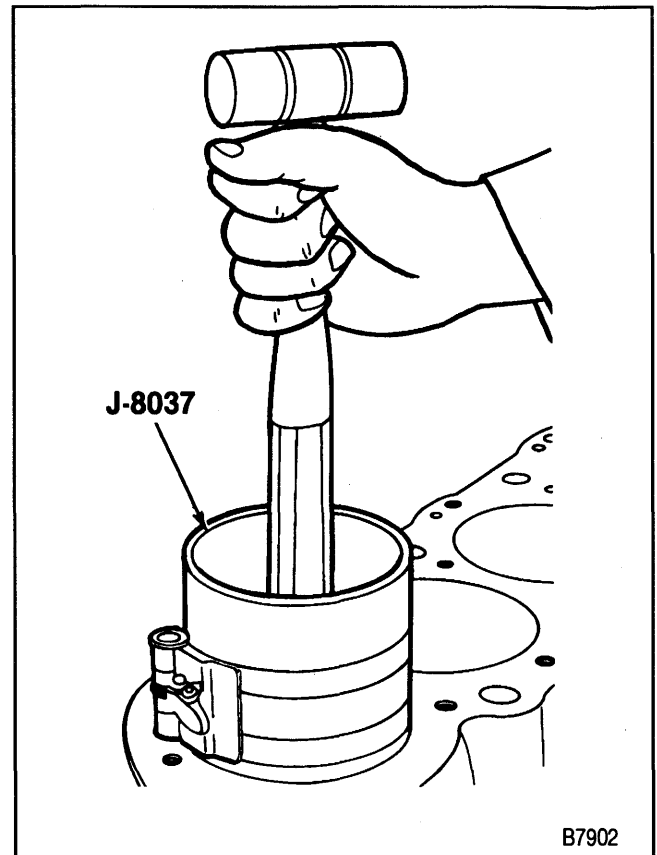


Figure 33—Installing the Piston

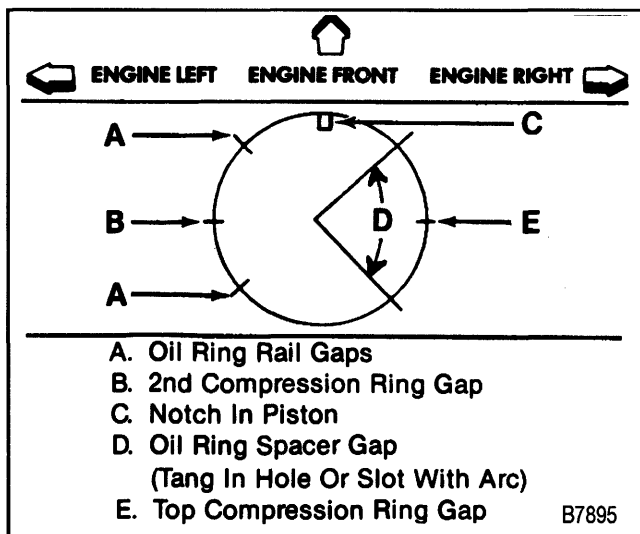


Figure 32—Piston Ring End Gap Location

5. Connecting rod cap. Check the connecting rod and cap for identification marks. Mark the parts if required. The connecting rod and cap must be kept together as mating parts.
6. Connecting rod and piston.
 - A. Attach J 5239 to the connecting rod bolts (figure 31).
 - B. Use the long guide rod of J 5239 to push the connecting rod and piston out of the bore.
7. Connecting rod bearing.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the components as necessary. Measure connecting rod bearing clearance, piston clearance, ring clearances, etc. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual.

The Light Duty Truck Unit Repair Manual contains information on:

- Connecting rod and piston.
- Piston rings.
- Connecting rod and crankpin.
- Cylinder bores.



Install or Connect (Figures 31 through 34)

Tools Required:

- J 5239 Connecting Rod Guide Set
- J 8037 Ring Compressor

- Make sure the cylinder walls are clean. Lubricate the cylinder wall lightly with engine oil.
 - Make sure the piston is installed in the matching cylinder.
1. Connecting rod bearings.
 - A. Be certain that the bearings are of the proper size.
 - B. Install the bearings in the connecting rod and connecting rod cap.
 - C. Lubricate the bearings with engine oil.
 2. Piston and connecting rod to the proper bore.
 - A. With the connecting rod cap removed, install J 5239 onto the connecting rod studs.
 - B. Locate the piston ring end gaps as shown in figure 32. Lubricate the piston and rings.

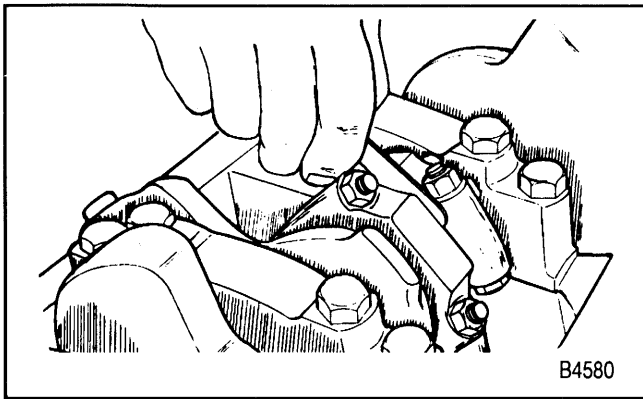


Figure 34—Measuring Connecting Rod Side Clearance

- C. Without disturbing the ring end gap location, install J 8037 over the piston (figure 33).
- D. The piston must be installed so that the notch in the piston faces the front of the engine (figure 32).
- E. Place the piston in its matching bore. The connecting rod bearing tang slots must be on the side opposite the camshaft. Using light blows with a hammer handle, tap the piston down into its bore (figure 33). At the same time, from beneath the vehicle guide the connecting rod to the crankpin with J 5239 (figure 31). Hold the ring compressor against the block until all rings have entered the cylinder bore.
- F. Remove J 5239 from the connecting rod bolts.

Important

- Each connecting rod and bearing cap should be marked, beginning at the front of the engine. Cylinders 1, 3, 5, and 7 are the left bank and, 2, 4, 6, and 8 are the right bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new connecting rod bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

Measure

- Connecting rod bearing clearance. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual.

3. Connecting rod cap and bearing.

NOTICE: Refer to "Notice" on page 6A4-1.

4. Connecting rod bolt nuts.

Tighten

- Connecting rod bolt nuts to 60 N.m (45 lbs. ft.).

Measure

- Connecting rod side clearance. Use a feeler gage between the connecting rods (figure 34). The correct clearance is 0.006-0.014 inch.
- Oil pump (if removed), as outlined previously.
 - Oil pan and cylinder head, as outlined previously.

OIL FILTER BYPASS VALVE

Remove or Disconnect (Figure 35)

- Oil filter.

Inspect

- Bypass valve spring and valve disc for proper operation, cracks, and damage. If replacement is needed, the oil filter bypass valve (93) must be replaced, as follows:
- Bolts (94).
 - Oil filter bypass valve (93).

Clean

- Valve chamber in the block.

Install or Connect (Figure 35)

- Oil filter bypass valve (93).

NOTICE: Refer to "Notice" on page 6A4-1.

- Bolts (94).

Tighten

- Bolts (94) to 26 N.m (20 lbs. ft.).
- Oil filter.
 - Engine oil, as needed.

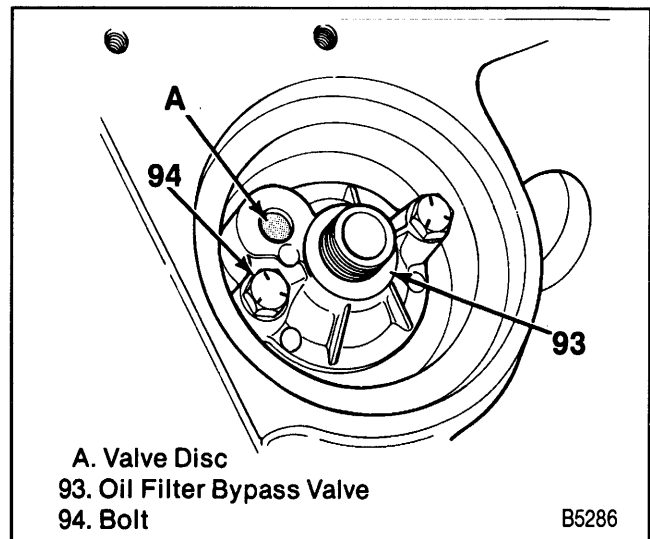


Figure 35—Oil Filter Bypass Valve

MAIN BEARING REPLACEMENT

↔ Remove or Disconnect (Figure 36)

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Spark plugs.
2. Oil pan, as outlined previously.
3. Oil pump, as outlined previously.
4. Main bearing caps.
 - Check the main bearing caps for location markings. Mark the caps if necessary. The caps must be returned to their original locations during assembly.
5. Lower main bearing inserts from the main bearing caps.
6. Upper main bearing inserts.
 - A. Insert J 8080 into the crankshaft oil hole (figure 36).
 - B. Rotate the crankshaft to "turn" the bearing insert out of the block.

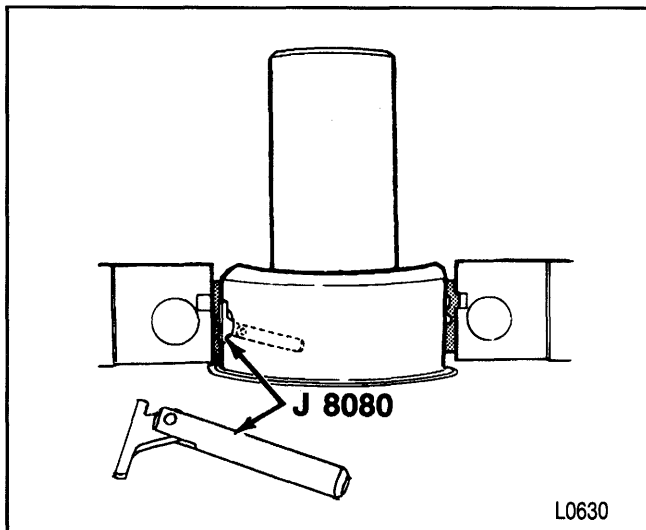


Figure 36—Removing the Main Bearing Insert

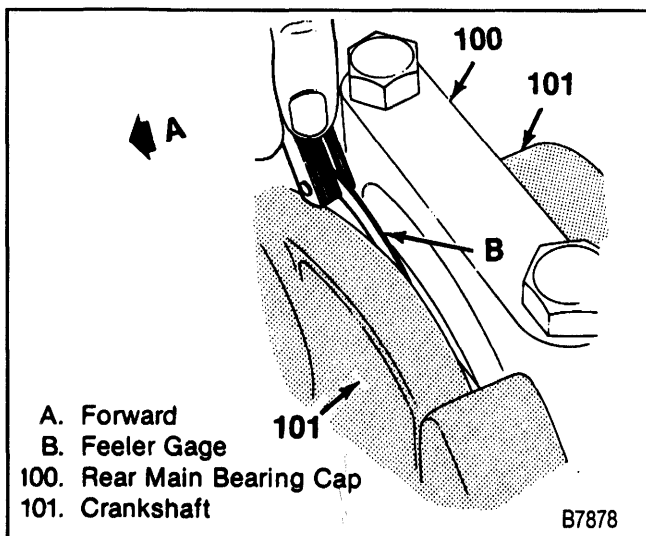


Figure 37—Measuring Crankshaft End Play

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the components as required. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual. The Unit Repair Manual contains information on

- Crankshaft.
- Main and connecting rod bearings.

↔ Install or Connect (Figures 36 and 37)

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A4-1.

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Upper main bearing inserts.
 - A. Insert tool J 8080 into a crankshaft main bearing oil hole (figure 36).
 - B. Apply engine oil to inserts of the proper size.
 - C. Insert the plain end (without the bearing tang) of the insert between the crankshaft and the notched side of the block.
 - D. Rotate the crankshaft to "roll" the insert into the block.
 - E. Remove the tool.
2. Lower main bearing inserts to the main bearing caps.
 - A. Make sure the inserts are of the proper size.
 - B. Apply engine oil to the inserts.

📏 Measure

- Main bearing clearance. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual. If the engine is in the vehicle, the crankshaft must be supported upward to remove any clearance from the upper bearing. The total clearance can then be measured between the lower bearing and journal.
3. Main bearing caps (except rear cap) and bolts to the block.

🔧 Tighten

- Main bearing cap bolts to specifications.
 - Outer bolts on #2, #3, and #4 main bearing caps: 95 N·m (70 lbs. ft.).
 - All others: 110 N·m (80 lbs. ft.).
4. Rear main bearing cap and bolts.

🔧 Tighten

- Rear main bearing cap bolts temporarily to 14 N·m (124 lbs. in.).

📏 Measure

- Crankshaft end play, as follows:
 - A. Tap the end of the crankshaft first rearward then forward with a lead hammer. This will line up the rear main bearing and crankshaft thrust surfaces.

B. Tighten the rear main bearing cap bolts to 110 N.m (80 lbs. ft.).

C. With the crankshaft forced forward, measure at the front end of the rear main bearing with a feeler gage (figure 37). The proper clearance is 0.002-0.006-inch.

- If correct end play cannot be obtained, be certain that the correct size rear main bearing has been installed. Production engines may have rear main bearings that are 0.008-inch wider across the thrust faces than standard. Refer to SECTION 6A5 of the Light Duty Truck Unit Repair Manual for more information.

5. Oil pump, as outlined previously.

6. Oil pan, as outlined previously.

7. Spark plugs.

CRANKSHAFT REPLACEMENT

1. Remove the engine, as outlined later in this section.
2. Refer to Section 6A5 of the Light Duty Truck Unit Repair Manual for crankshaft replacement procedures.

FLYWHEEL REPLACEMENT (AUTOMATIC AND MANUAL TRANSMISSIONS)



Remove or Disconnect

1. Transmission, flywheel housing, and clutch.
2. Flywheel bolts.
3. Flywheel.



Clean

- Mating surfaces of crankshaft and flywheel. Remove any burrs.



Inspect

- Flywheel for burning, scoring, warping, and wear. Replace the flywheel if necessary. Do not machine the flywheel.
- Flywheel ring gear for worn or broken teeth.

FLYWHEEL RING GEAR REPLACEMENT

1. Use a torch to heat the gear around the entire circumference, then drive the gear off the flywheel, using care not to damage the flywheel.

NOTICE: Never heat starter gear to red heat as this will change metal structure.

2. Uniformly heat the flywheel gear to temperature which will expand the gear to permit installation. Temperature must not exceed 204° C (400° F).
3. As soon as the gear has been heated, install on the flywheel.



Install or Connect

1. Flywheel.

NOTICE: Refer to "Notice" on page 6A4-1.

2. Flywheel bolts.



Tighten

- Flywheel bolts to 100 N.m (75 lbs. ft.).

3. Clutch, flywheel housing, and transmission.

ENGINE MOUNTINGS

NOTICE: Broken or deteriorated mountings can cause misalignment and eventual destruction of certain drive train components. When a single mounting breakage occurs, the remaining mountings are subjected to abnormally high stresses.

INSPECTING ENGINE MOUNTINGS

Front Engine Mountings

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

1. Raise the engine to remove weight from the mountings and to place a slight tension on the rubber cushion. Observe both mountings while raising the engine.
2. Replace the mounting if the following conditions exist:

- Hard rubber surface covered with heat check cracks.
- Rubber cushion separated from the metal plate of the mounting.
- Rubber cushion split through the center.

3. If there is movement between a metal plate of the mounting and its attaching points, lower the engine and tighten the bolts or nuts attaching the mounting to the engine, frame, or bracket.

Rear Mountings

1. Push up and pull down on the transmission tailshaft. Observe the transmission mounting.
2. Replace the mounting if the following conditions exist:

- Rubber cushion separated from the metal plate of the mounting.
- Mounting bottomed out (tailshaft can be moved up but not down).

3. If there is relative movement between a metal plate of the mounting and its attaching point, tighten the bolts or nuts attaching the mounting to the transmission or crossmember.

FRONT MOUNTING REPLACEMENT

- ↔ Remove or Disconnect (Figures 38, 39, and 40)

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the engine with a suitable jack. Do not load the engine mounting.
1. Engine mounting through-bolt and nut.

NOTICE: Raise the engine only enough for sufficient clearance. Check for interference between the rear of the engine and the dash panel which could cause distributor housing damage.

- Raise the engine only enough to permit removal of the engine mounting.
2. Mounting assembly bolts, nuts, and washers.
 3. Mounting assembly.

- ↔ Install or Connect (Figures 38, 39, and 40)

NOTICE: For steps 2 and 3, refer to "Notice" on page 6A4-1.

1. Mounting assembly.
2. Mounting assembly bolts, nuts, and washers.

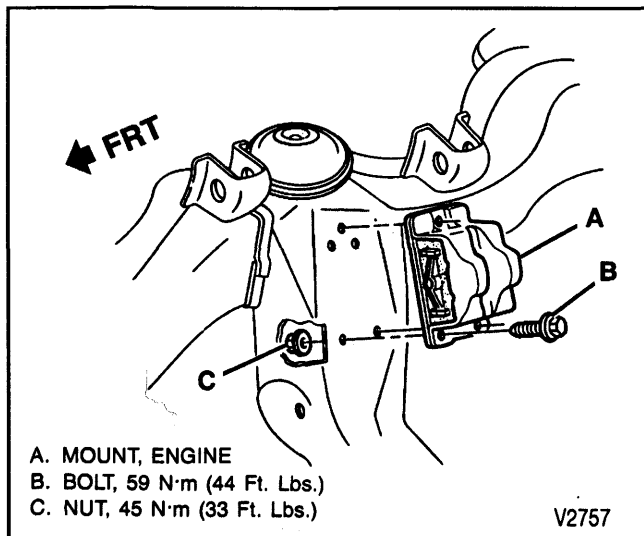


Figure 38—Front Engine Mounting Brackets to Frame (C-Models)

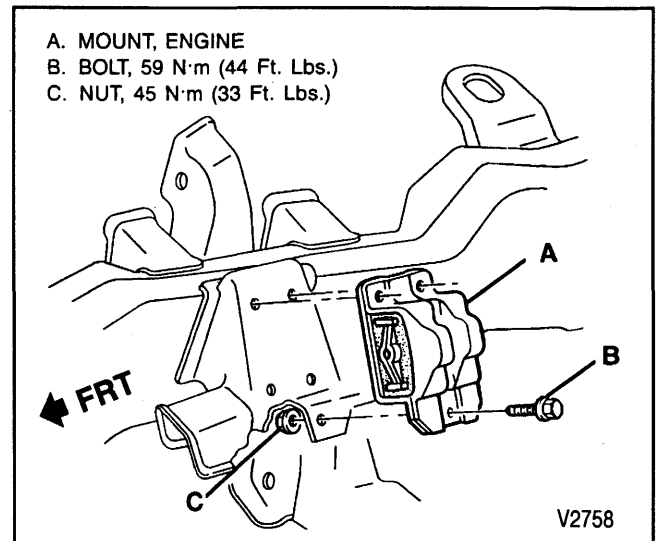


Figure 39—Front Engine Mounting Brackets to Frame (K-Models)

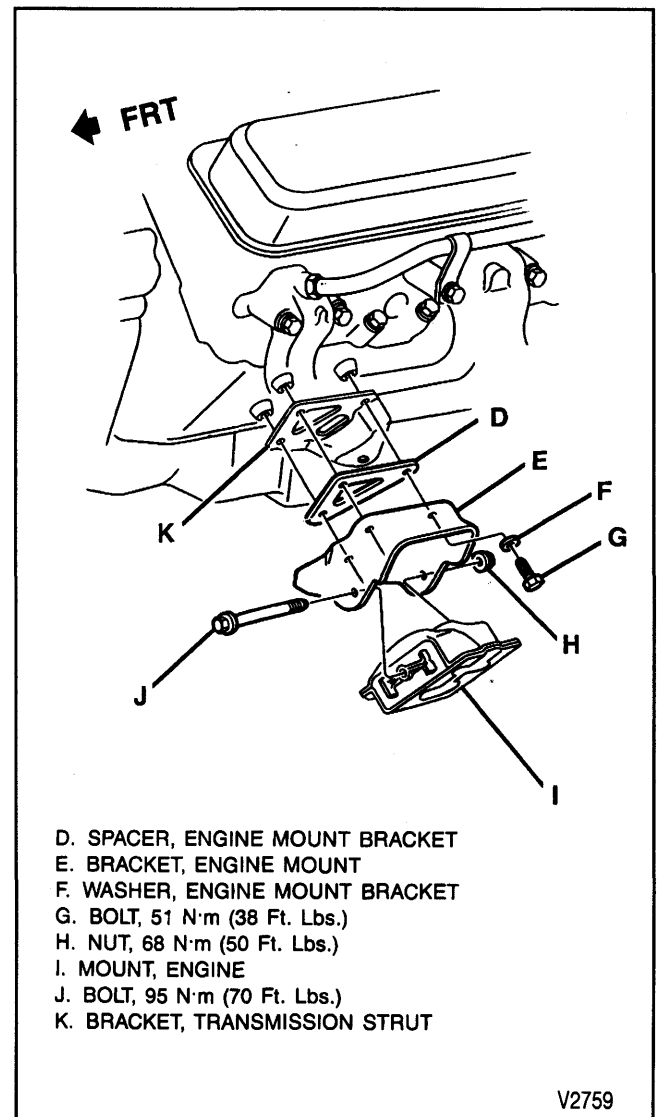


Figure 40—Front Engine Mounts to Brackets



Tighten

- Fasteners to specifications. Refer to figures 38 and 39.

3. Engine mount through-bolt and nut lower the engine until the bolt can be inserted. Install the nut.



Tighten

- Through-bolt nut to specifications. Refer to figure 40.

REAR MOUNTING REPLACEMENT



Remove or Disconnect (Figures 41 and 42)

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the rear of the engine to relieve the weight on the rear mountings.
1. Mounting to crossmember nut(s) and washer(s).
 2. Mounting to transmission bolts and washers.
- Raise the rear of the engine only enough to permit removal of the mounting.

3. Mounting.



Install or Connect (Figures 41 and 42)

NOTICE: For steps 2 and 3, refer to "Notice" on page 6A4-1.

1. Mounting.

- Lower the rear of the engine.
2. Mounting to transmission bolts and washers.
 3. Mounting to crossmember nut(s) and washer(s).



Tighten

- Fasteners to specifications. Refer to figures 41 and 42.

ENGINE REPLACEMENT



Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
2. Hood.
 - Drain the cooling system.
3. Air cleaner.
4. Accessory drive belt.
5. Fan and coolant pump pulley.
6. Radiator and shroud.
7. Heater hoses at the engine.
8. Accelerator and cruise control linkage from TBI unit (if equipped).

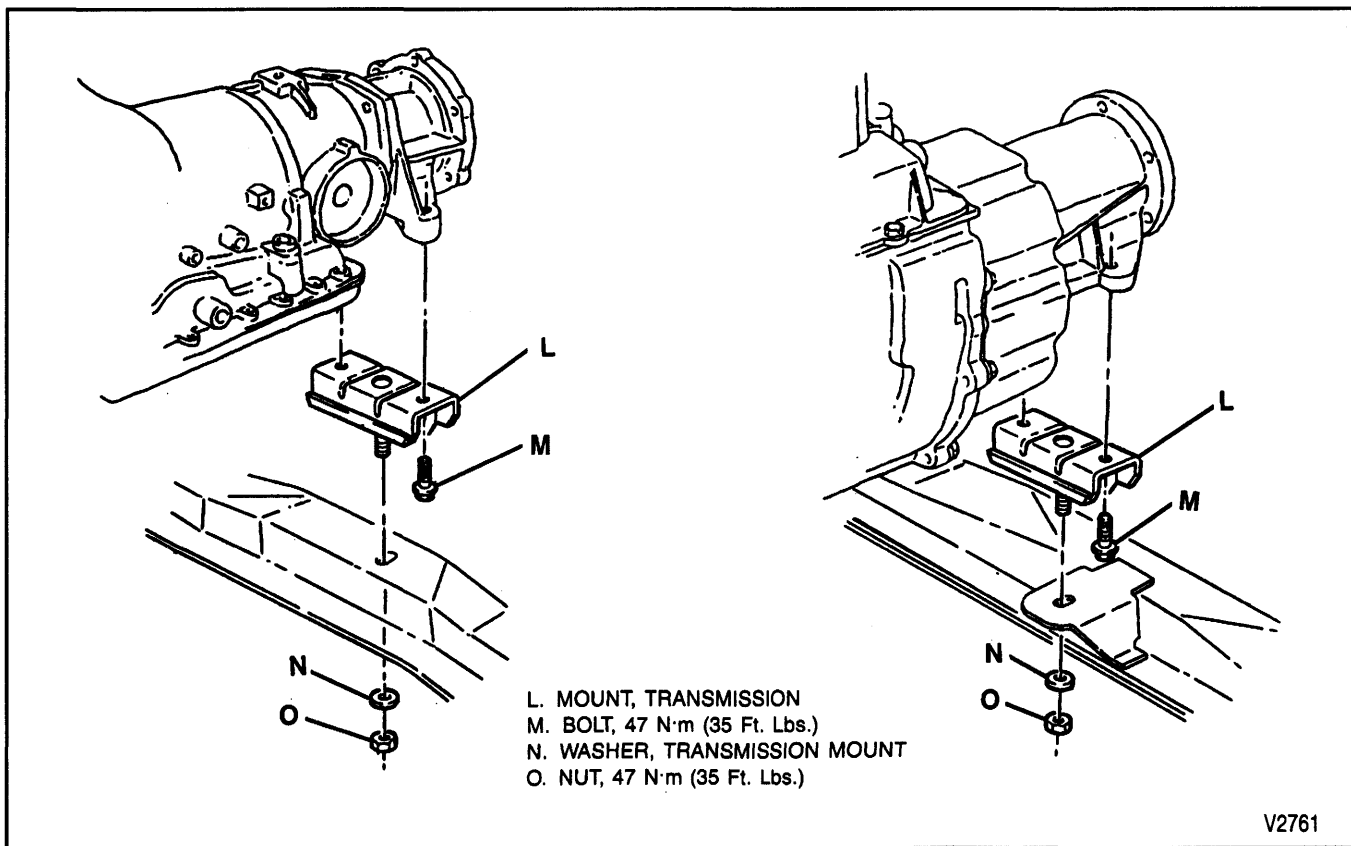
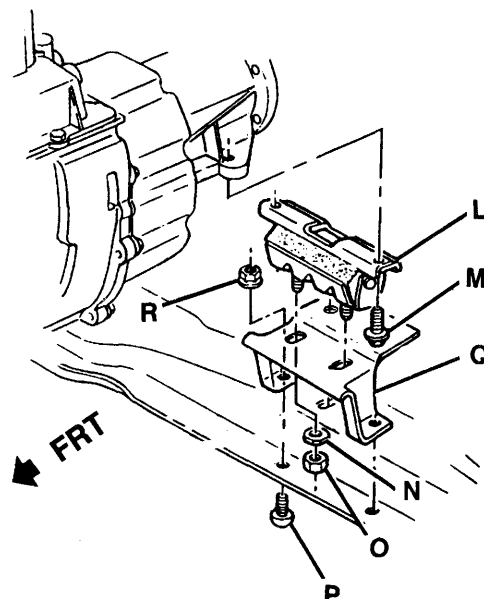
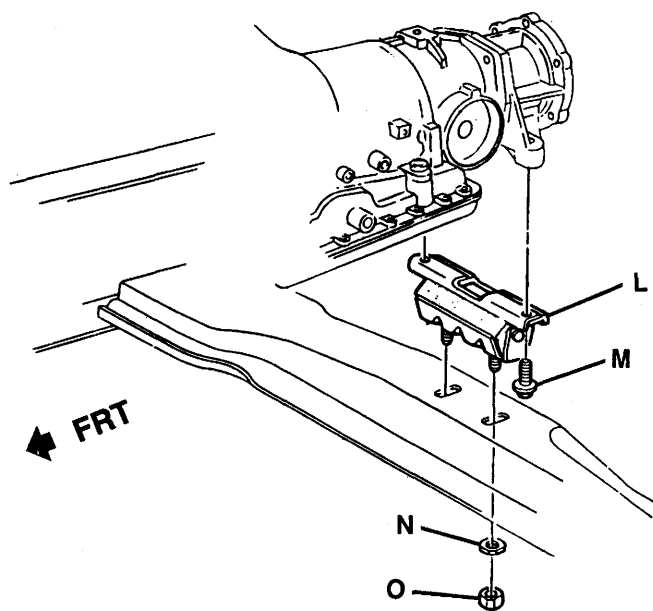


Figure 41—Rear Engine Mounting (C-Models)

- L. MOUNT, TRANSMISSION
M. BOLT, 47 N·m (35 Ft. Lbs.)
N. WASHER, TRANSMISSION MOUNT
O. NUT, 47 N·m (35 Ft. Lbs.)
P. BOLT, TRANSMISSION MOUNT BRACKET
Q. BRACKET, TRANSMISSION MOUNT
R. NUT, 35 N·m (26 Ft. Lbs.)



V2762

Figure 42—Rear Engine Mounting (2WD with 15,000 GVW and 4WD Models)

9. Air conditioning compressor (if equipped) and lay aside.
10. Power steering pump (if equipped) and lay aside.
11. Engine wiring harness from the engine.
12. Fuel lines.
13. Vacuum lines from the intake manifold.
 - Raise the vehicle. Support with safety stands.
 - Drain the crankcase oil.
14. Exhaust pipes from the manifolds.
15. Strut rods at the engine mountings (if used).
16. Flywheel or torque converter underpan.
17. Wiring along oil pan rail (if used).
18. Starter.
19. Wiring, as necessary.
20. Converter to flex plate bolts.
 - Lower the vehicle.
 - Support the transmission.
 - Attach a suitable lifting fixture.
21. Bell housing to engine bolts.
22. Front engine mounting to frame bolts.
23. Engine.



Install or Connect (Figure 38, 39, and 40)

1. Engine to the vehicle.
 - Raise the vehicle. Support with safety stands.

NOTICE: Refer to "Notice" on page 6A4-1.

2. Front engine mounting to frame bolts.



Tighten

- Fasteners to specifications. Refer to figures 38, 39, and 40.
3. Bell housing to engine bolts. Remove the transmission support.
 4. Converter to flex plate bolts.
 5. Wiring, as required.
 6. Starter.
 7. Wiring along oil pan rail (if used).
 8. Flywheel or torque converter underpan.
 9. Strut rods at the engine mountings (if used).
 10. Exhaust pipes to the manifolds.
 - Lower the vehicle.

11. Vacuum lines to the intake manifold.
12. Fuel line.
13. Engine wiring harness.
14. Power steering pump (if equipped).
15. Air conditioning compressor (if equipped).
16. Accelerator and cruise control linkages (if equipped).
17. Heater hoses.

18. Radiator and shroud.
19. Accessory drive belt.
20. Air cleaner.
21. Hood.
22. Proper quantity and grade of coolant and crank-case oil. Refer to SECTION 0B.
23. Negative battery cable.

THREAD REPAIR

Damaged threads may be reconditioned by drilling out, rethreading, and installing a suitable thread insert.

Tools Required:

General purpose thread repair kits are available commercially.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch, and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to required depth.

Important

- Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.

2. Drill out damaged thread. Clean out chips.
3. Tap hole. Lubricate tap with light engine oil. Clean the thread.

Important

- Avoid buildup of chips. Back out the tap every few turns and remove chips.

4. Thread the thread insert onto the mandrel of the installer (figure 43). Engage the tang of the insert onto the end of the mandrel.
5. Lubricate the insert with light engine oil (except when installing in aluminum) and install.

Important

- When correctly installed, the insert should be flush to one turn below the surface.

6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

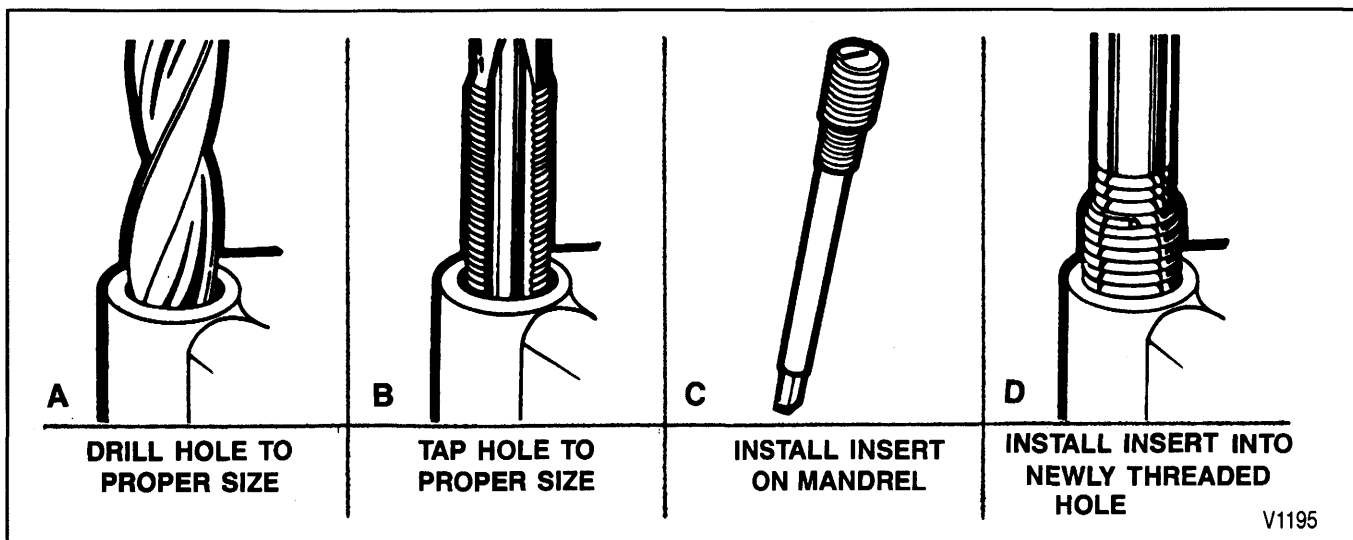


Figure 43—Repairing Thread Holes

SPECIFICATIONS

ENGINE SPECIFICATIONS (5.0L/5.7L)

All Specifications are in INCHES unless otherwise noted.

GENERAL DATA:				
Type			V8	
Displacement			5.0L (305 CID)	5.7L (350 CID)
RPO (VIN Code)			L03 (H)	L05 (K)
Bore			3.736	4.00
Stroke			3.480	
Compression Ratio			9.1:1	*
Firing Order			1-8-4-3-6-5-7-2	
Oil Pressure (Minimum)			6 PSI @ 1000 RPM; 18 PSI @ 2000 RPM; 24 PSI @ 4000 RPM	
CYLINDER BORE:				
Diameter			3.7350-3.7385	3.9995-4.0025
Out Of Round	Production		0.001 (Maximum)	
	Service		0.002 (Maximum)	
Taper	Production	Thrust Side	0.0005 (Maximum)	
		Relief Side	0.001 (Maximum)	
	Service		0.001 (Maximum)	
PISTON:				
Clearance	Production		0.0007-0.0021	
	Service Limit		0.0027 (Maximum)	
PISTON RING:				
C O M P R E S S I O N	Groove Clearance	Production	Top	0.0012-0.0032
			2nd	
		Service Limit		Hi Limit Production $\pm$ 0.001
	Gap	Production	Top	0.010-0.020
			2nd	0.018-0.026
		Service Limit		Hi Limit Production $\pm$ 0.010
O I L	Groove Clearance	Production	0.002-0.007	
		Service Limit	Hi Limit Production $\pm$ 0.001	
	Gap	Production	0.010-0.030	
		Service Limit	Hi Limit Production $\pm$ 0.010	
PISTON PIN:				
Diameter			0.9269-0.09271	
Clearance In Piston	Production		0.0002-0.0007	
	Service Limit		0.001 (Maximum)	
Fit In Rod			0.0008-0.0016 Interference	

*8.3:1 (Over 8500-lb. GVW)

9.1:1 (Under 8500-lb. GVW)

SPECIFICATIONS

ENGINE SPECIFICATIONS (5.0L/5.7L) (Cont.)

All specifications are in INCHES unless otherwise noted.

DISPLACEMENT:			5.0L (305 Cu. In.)	5.7L (350 Cu. In.)
CRANKSHAFT:				
Main Journal	Diameter	#1	2.4484-2.4493	
		#2, #3, #4	2.4481-2.4490	
		#5	2.4479-2.4488	
	Taper	Production	0.0002 (Maximum)	
		Service Limit	0.001 (Maximum)	
	Out Of Round	Production	0.0002 (Maximum)	
Service Limit		0.001 (Maximum)		
Main Bearing Clearance	Production	#1	0.0008-0.0020	
		#2, #3, #4	0.0011-0.0023	
		#5	0.0017-0.0032	
	Service Limit	#1	0.0010-0.0015	
		#2, #3, #4	0.0010-0.0025	
		#5	0.0025-0.0035	
Crankshaft End Play			0.002-0.006	
Crankpin	Diameter		2.0988-2.0998	
	Taper	Production	0.0005 (Maximum)	
		Service Limit	0.001 (Maximum)	
	Out Of Round	Production	0.0005 (Maximum)	
		Service Limit	0.001 (Maximum)	
Rod Bearing Clearance	Production		0.0013-0.0035	
	Service Limit		0.003 (Maximum)	
Rod Side Clearance			0.006-0.014	
CAMSHAFT:				
Lobe Lift ±0.002	Intake		0.2336	0.2565
	Exhaust		0.2565	0.2690
Journal Diameter			1.8682-1.8692	
Camshaft End Play			0.004-0.012	
VALVE SYSTEM:				
Lifter			Hydraulic	
Rocker Arm Ratio			1.50:1	
Valve Lash		Intake	One Turn Down From Zero Lash	
		Exhaust		
Face Angle (Intake & Exhaust)			45°	
Seat Angle (Intake & Exhaust)			46°	
Seat Runout (Intake & Exhaust)			0.002 (Maximum)	
Seat Width		Intake	1/32-1/16	
		Exhaust	1/16-3/32	
Stem Clearance	Production	Intake	0.0010-0.0027	
		Exhaust	0.0010-0.0027	
	Service	Intake	High Limit Production +0.001	
		Exhaust	High Limit Production +0.002	
Valve Spring (Outer)	Free Length		2.03	
	Pressure lbs. @ in.	Closed	76-84 lbs. @ 1.70"	
		Open	194-206 lbs. @ 1.25"	
	Installed Height ±1/32"		1 23/32	
Valve Spring Damper	Free Length		1.86	
	Approx. # of Coils		4	

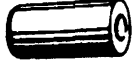
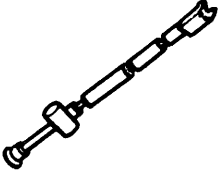
SPECIFICATIONS (CONT.)

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Ft. Lbs.	In. Lbs.
Camshaft Sprocket Bolts	28	21	—
Connecting Rod Bolt Nuts	60	45	—
Coolant Outlet Bolts	28	21	—
Coolant Pump Bolts	40	30	—
Crankshaft Rear Oil Seal Retainer Screws and Nuts	15	11	—
Cylinder Head Bolts (In Sequence).....	90	65	—
Engine Block Drain Plug.....	22	16	—
Exhaust Manifold Bolts			
Center Two Bolts	36	26	—
All Other Bolts.....	28	20	—
Flywheel Bolts	100	75	—
Flywheel Housing Bolts.....	44	32	—
Front Cover Bolts	11	—	100
Intake Manifold Bolts (In Sequence).....	48	35	—
Main Bearing Cap Bolts			
Outer Bolts on #2, #3, and #4 Caps.....	95	70	—
All Others	110	80	—
Oil Filter Bypass Valve Bolts	26	20	—
Oil Pan Baffle Nuts (H.D. 5.7L Only)	36	26	—
Oil Pan Bolts	11	—	100
Oil Pan Drain Plug	22	16	—
Oil Pan Nuts	22	16	—
Oil Pan Studs to Oil Seal Retainer or Engine Block	2	—	15
Oil Pump Bolt	90	65	—
Oil Pump Cover Bolts	9	—	80
Rocker Arm Cover Bolts	10	—	90
Spark Plugs	20	15	—
Torsional Damper Bolt.....	95	70	—

T2122

SPECIAL TOOLS

- | | | | | | |
|----|---|-----------|-----|--|-----------|
| 1. |  | J 39046 | 10. |  | J 3049-A |
| 2. |  | J 5892-C | 11. |  | J 5802-01 |
| 3. |  | J 23590 | 12. |  | J 5715 |
| 4. |  | J 35468 | 13. |  | J 6036 |
| 5. |  | J 8080 | 14. |  | J 6880 |
| 6. |  | J 8037 | 15. |  | J 5825-A |
| 7. |  | J 5239 | 16. |  | J 5590 |
| 8. |  | J 23738-A | 17. |  | J 8520 |
| 9. |  | J 9290-01 | 18. |  | J 35621 |

1. TORSIONAL DAMPER REMOVER AND INSTALLER
2. VALVE SPRING COMPRESSOR
3. AIRE ADAPTER
4. CRANKSHAFT SEAL INSTALLER AND CENTERING TOOL
5. MAIN BEARING REPLACER
6. PPISTON RING COMPRESSOR
7. GUIDE SET
8. VACUUM PUMP
9. HYUDRAULIC LIFTER REMOVER (SLIDE HAMMER TYPE)

10. HYDRAULIC LIFTER REMOVER (PLIER TYPE)
11. STUD REMOVER
12. REAMER (0.003-INCH OVER SIZE)
13. REAMER (0.013-INCH OVERSIZE)
14. STUD INSTALLER
15. CRANKSHAFT GEAR PULLER
16. CRANKSHAFT GEAR INSTALLER
17. DIAL INDICATOR ADAPTER
18. REAR CRANKSHAFT SEAL INSTALLER

SECTION 6A5

7.4L V8

RPO L19, VIN N

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

7.4L (454 CID) engines are 90-degree V8 type, overhead valve, liquid cooled, with cast iron block and heads.

For engine identification, refer to SECTION 0A. For engine component identification, refer to figures 1 through 4.

The crankshaft is supported by five precision insert main bearings, with crankshaft thrust taken at the number five (rear) bearing.

The camshaft is supported by five plain type bearings and chain driven. Motion from the camshaft is transmitted to the valves by hydraulic lifters, pushrods, and ball type rocker arms. The valve guides are pressed in the cylinder head.

The pistons are cast aluminum alloy and the connecting rods are forged steel with precision insert type crankpin bearings. The piston pins are a press fit in the connecting rods and a floating fit in the piston.

ENGINE LUBRICATION

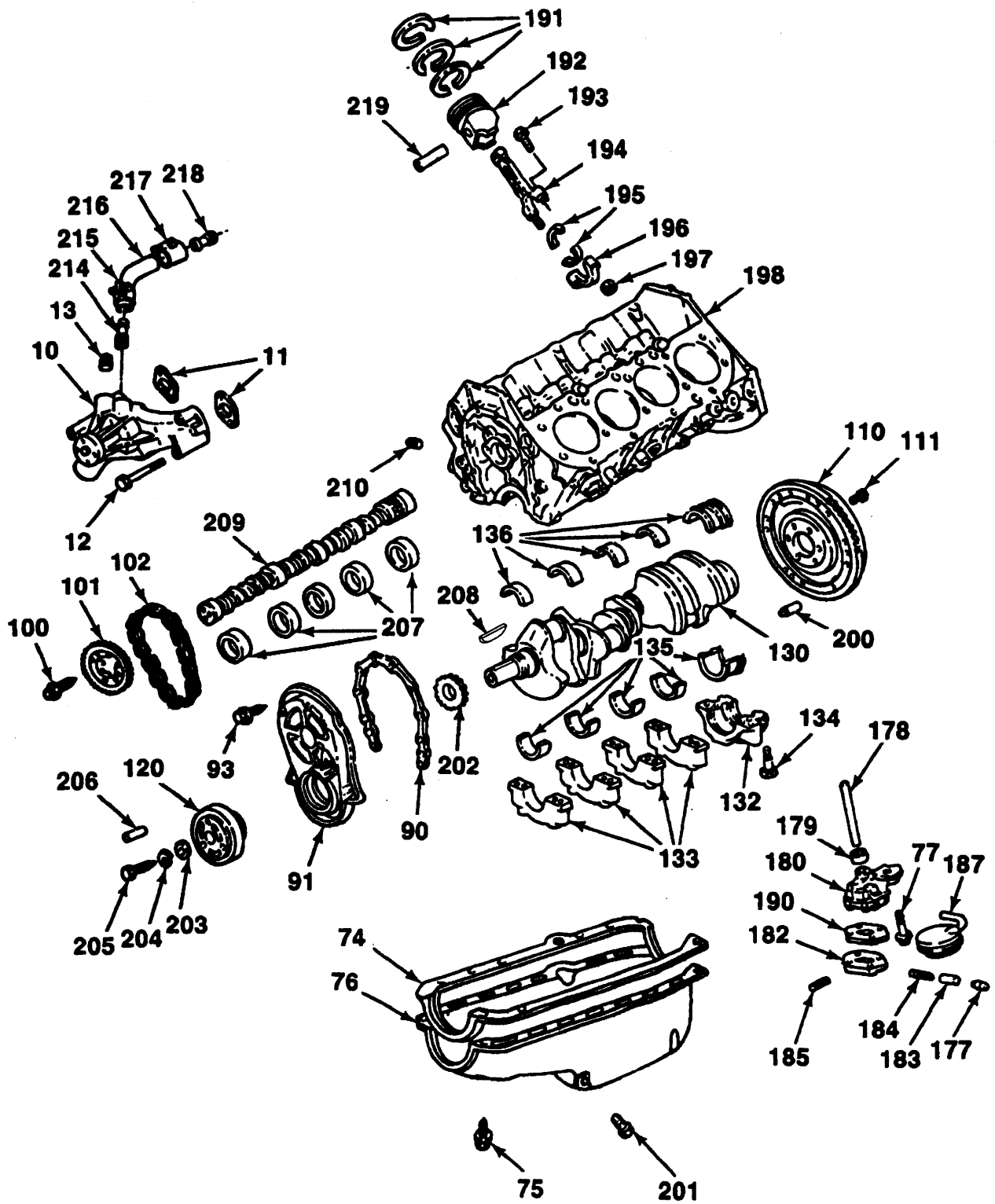
A lubrication schematic is shown in figure 5. The gear type oil pump is driven from the distributor shaft, which is gear driven from the camshaft. Oil is drawn into the oil pump through a pickup screen and pipe.

Pressurized oil is routed to the oil filter. A bypass valve is provided to prevent excessive oil pressure. Filtered oil flows into the main gallery and then to the camshaft and crankshaft bearings. The valve lifter oil gallery supplies oil to the valve lifters. Oil flows from the hydraulic lifters through the hollow pushrods to the rocker arms. Oil from overhead drains back to the crankcase through oil drain holes.

The timing chain is drip fed from the front camshaft bearing. The pistons and piston pins are lubricated by oil splash.

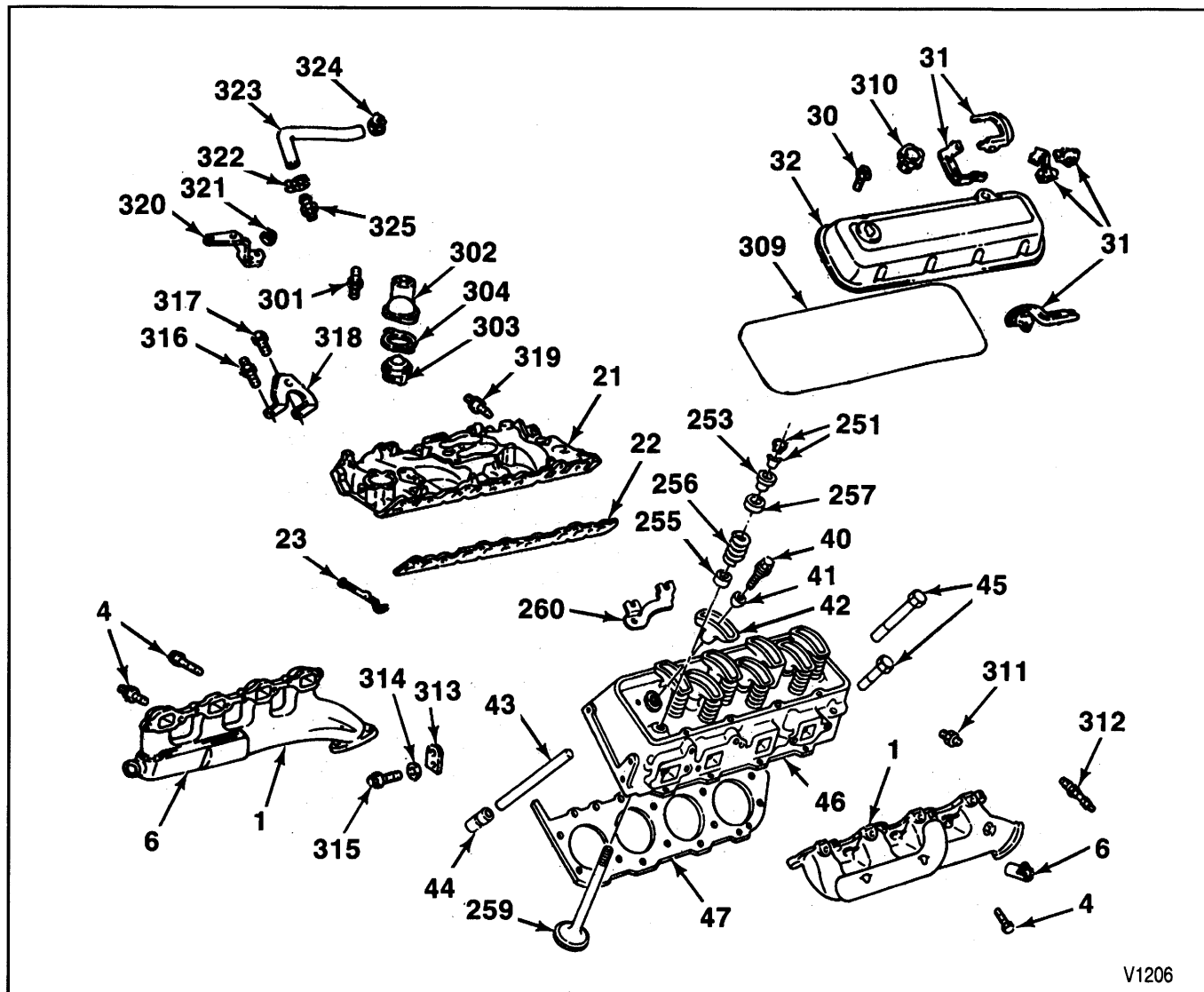
- | | |
|--------------------------------------|--|
| 10. Coolant Pump | 184. Oil Pressure Regulator Valve Spring |
| 11. Coolant Pump Gasket | 185. Spring Retaining Pin |
| 12. Coolant Pump Bolt | 187. Pick-up Screen and Pipe |
| 13. Coolant Pump Plug | 190. Gasket |
| 74. Oil Pan Gasket | 191. Piston Rings |
| 75. Oil Pan Bolt | 192. Piston |
| 76. Oil Pan | 193. Connecting Rod Bolt |
| 77. Oil Pump Bolt | 194. Connecting Rod |
| 90. Front Cover Gasket | 195. Connecting Rod Bearing |
| 91. Front Cover | 196. Connecting Rod Bearing Cap |
| 93. Front Cover Bolt | 197. Connecting Rod Nut |
| 100. Camshaft Sprocket Bolt | 198. Engine Block |
| 101. Camshaft Sprocket | 200. Engine Balance Groove Pin |
| 102. Timing Chain | 201. Oil Pan Drain Plug |
| 110. Flywheel | 202. Crankshaft Sprocket |
| 111. Flywheel Bolt | 203. Washer |
| 120. Torsional Damper | 204. Spring Lock Washer |
| 130. Crankshaft | 205. Bolt |
| 132. Rear Main Bearing Cap | 206. Engine Balance Groove Pin |
| 133. Main Bearing Cap | 207. Camshaft Bearings |
| 134. Main Bearing Cap Bolt | 208. Woodruff Key |
| 135. Lower Main Bearing Insert | 209. Camshaft |
| 136. Upper Main Bearing Insert | 210. Drain Plug |
| 177. Regulator Valve Spring Retainer | 214. Nipple |
| 178. Oil Pump Driveshaft | 215. Clamp |
| 179. Connector | 216. Hose |
| 180. Oil Pump Body | 217. Clamp |
| 182. Oil Pump Cover | 218. Nipple |
| 183. Oil Pressure Regulator Valve | 219. Piston Pin |

Figure 1—Cylinder Block and Components - Legend



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Figure 2—Cylinder Block and Components



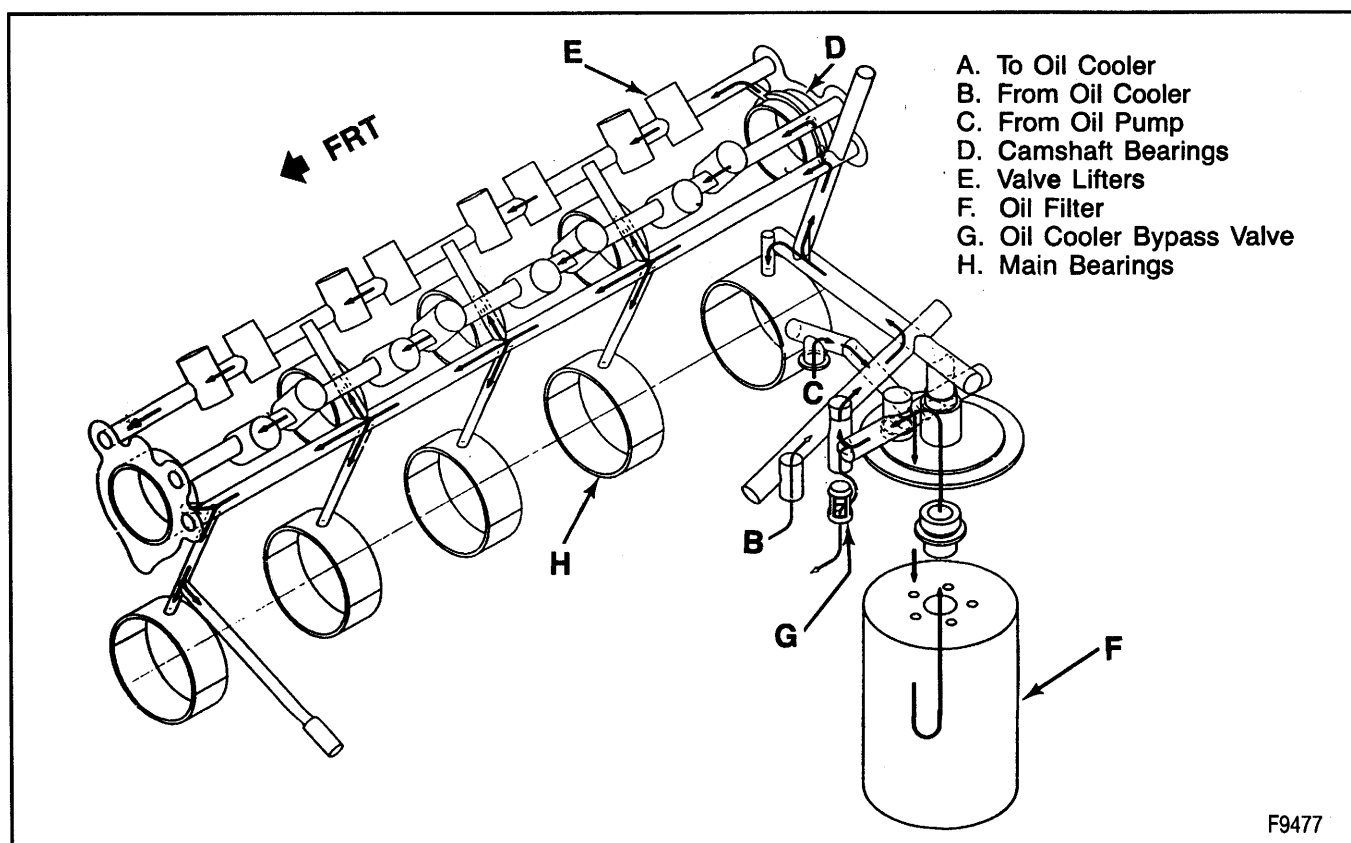
V1206

Figure 3—Cylinder Head, Manifolds, and Components

- | | |
|----------------------------|--|
| 1. EXHAUST MANIFOLD | 260. PUSHROD GUIDE |
| 4. BOLT/STUD | 301. STUD |
| 6. HEAT SHIELD ASSEMBLY | 302. COOLANT OUTLET |
| 21. INTAKE MANIFOLD | 303. THERMOSTAT |
| 22. INTAKE MANIFOLD GASKET | 304. GASKET |
| 23. INTAKE MANIFOLD SEAL | 309. ROCKER COVER GASKET |
| 30. ROCKER COVER BOLT | 310. OIL FILLER CAP |
| 31. SUPPORT | 311. COOLANT TEMPERATURE SENSOR |
| 32. ROCKER ARM COVER | 312. SPARK PLUG |
| 40. ROCKER ARM BOLT | 313. ENGINE LIFT BRACKET |
| 41. ROCKER ARM BALL | 314. SPRING LOCK WASHER |
| 42. ROCKER ARM | 315. BOLT |
| 43. PUSHROD | 316. STUD |
| 44. HYDRAULIC LIFTER | 317. BOLT |
| 45. CYLINDER HEAD BOLT | 318. ENGINE LIFT BRACKET |
| 46. CYLINDER HEAD | 319. STUD |
| 47. CYLINDER HEAD GASKET | 320. EGR ELECTRONIC VACUUM
REGULATOR SOLENOID VALVE BRACKET |
| 251. VALVE STEM KEY | 321. NUT |
| 253. VALVE SPRING CAP | 322. CLAMP |
| 255. VALVE SPRING DAMPER | 323. HOSE |
| 256. VALVE SPRING | 324. CLAMP |
| 257. VALVE STEM OIL SEAL | 325. NIPPLE |
| 259. INTAKE VALVE | |

V1207

Figure 4—Cylinder Head, Manifolds, and Components - Legend



F9477

Figure 5—Engine Lubrication Diagram

ON-VEHICLE SERVICE

ROCKER ARM COVER REPLACEMENT

Remove or Disconnect (Figure 6)

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
3. Crankcase ventilation pipe or PCV valve at the rocker arm cover.
4. Wiring harnesses from the clips and move aside.
5. Spark plug wire loom bracket at the rear of the cylinder head. Move the spark plug wire loom out of the way.
6. Heat stove pipe (right side cover).
7. Generator left rear brace (left side cover).
8. Rocker arm cover bolts (30) and supports (31).
9. Rocker arm cover (32) and gasket.

Clean

- All traces of old gasket from the rocker arm cover and cylinder head.

Inspect

- Rocker arm cover sealing surface for distortion. Replace if necessary.

Install or Connect (Figure 6)

1. Rocker arm cover (32) and new gasket.
- NOTICE:** Refer to "Notice" on page 6A5-1.
2. Supports (31) and bolts (30).

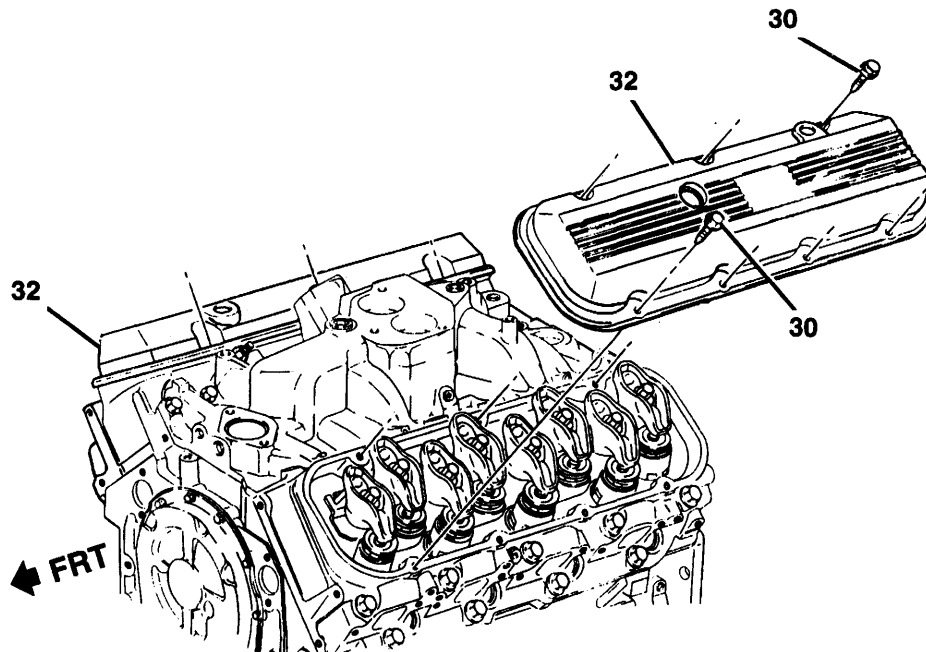
Tighten

- Bolts to 7 N.m (70 lbs. in.).
3. Generator left brace (left side cover). Refer to SECTION 6D3.
 4. Heat stove pipe (if removed).
 5. Spark plug wire loom bracket.
 6. Crankcase ventilation hoses.
 7. Air cleaner.
 8. Negative battery cable.

ROCKER ARM AND PUSHROD REPLACEMENT

Remove or Disconnect

1. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
2. Rocker arm bolt.
 - If only the pushrod is to be replaced, back the rocker arm bolt off until the rocker arm can be swung away from the pushrod. Then pull the pushrod out.



30. BOLT
32. ROCKER ARM COVER

F9326

Figure 6—Rocker Arm Cover

3. Rocker arm with ball.
4. Pushrod and pushrod guide.

Important

- Store used components in order so they can be reassembled in the same location.

Inspect

- Rocker arm bolts for signs of cracking at the bolt shoulder.
- Rocker arms and balls at their mating surfaces. These surfaces should be smooth and free from scoring or other damage.
- Rocker arm areas that contact the valve stems and the sockets that contact the pushrods. These areas should be smooth and free of damage and wear.
- Pushrods for bending. Roll the pushrod on a flat surface to determine if it is bent. Replace if necessary.
- Ends of the pushrods for scoring or roughness.

Install or Connect

1. Pushrod and pushrod guide. Make sure the pushrod seats properly in the hydraulic lifter.
2. Rocker arm with ball.

Important

- When new rocker arms and/or balls are installed, coat their bearing surfaces with high viscosity oil with zinc (GM P/N 12345501) or equivalent.

NOTICE: Refer to "Notice" on page 6A5-1.

3. Rocker arm bolt.

Tighten

- Bolt to 54 N.m (40 lbs. ft.).
4. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."

VALVE STEM SEAL AND VALVE SPRING REPLACEMENT

Remove or Disconnect (Figures 7 and 8)

Tools Required:

- J 23590 Air Adapter
- J 5892-C Spring Compressor

1. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
2. Rocker arms. Refer to "Rocker Arm and Pushrod Replacement."
3. Spark plugs.
4. Valve keepers.
 - A. Install J 23590 into the spark plug hole.
 - B. Apply compressed air to hold the valves in place.

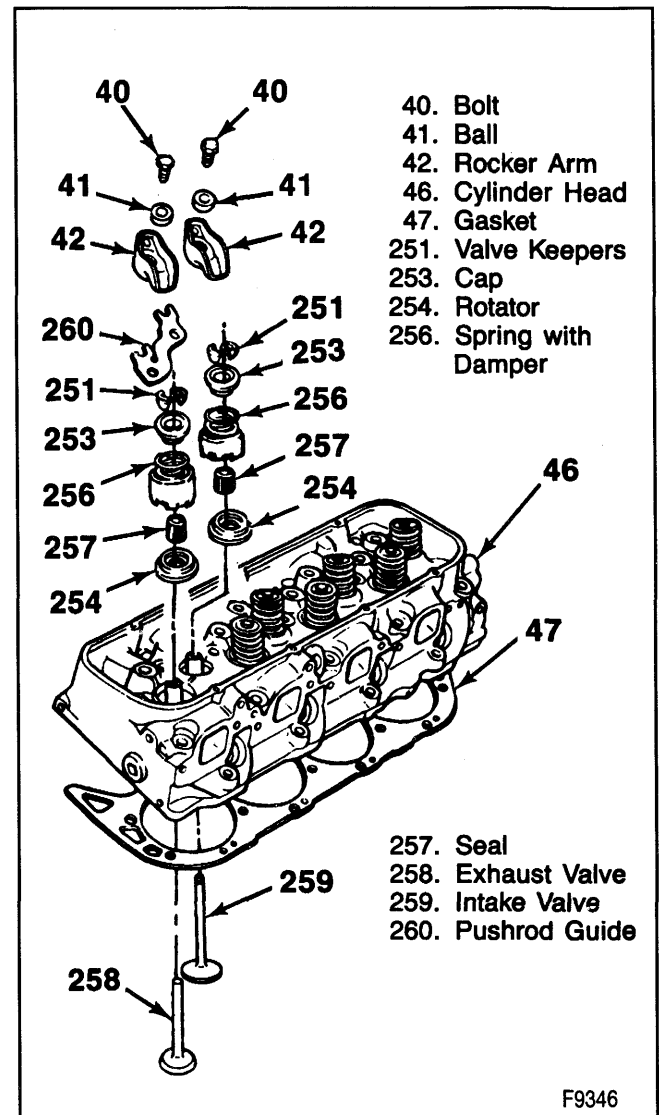


Figure 7—Cylinder Head and Components

- C. Install a rocker arm bolt (figure 8).
- D. Use J 5892-C to compress the valve spring (figure 8).
- E. Remove the valve keepers.
- F. Carefully release the spring tension. Remove J 5892-C.
5. Cap (25) and spring with damper (23).
6. Seal (24).

Install or Connect (Figures 7 and 8)

Tools Required:

- J 23590 Air Adapter
- J 5892-C Spring Compressor

1. New seal. Install the seal over the valve stem and seat it against the head.
2. Spring with damper, and cap.
3. Valve keepers.
 - A. With air pressure applied to the cylinder with J 23590, compress the spring with J 5892-C (figure 8).
 - B. Install the valve keepers. Use grease to hold them in place.

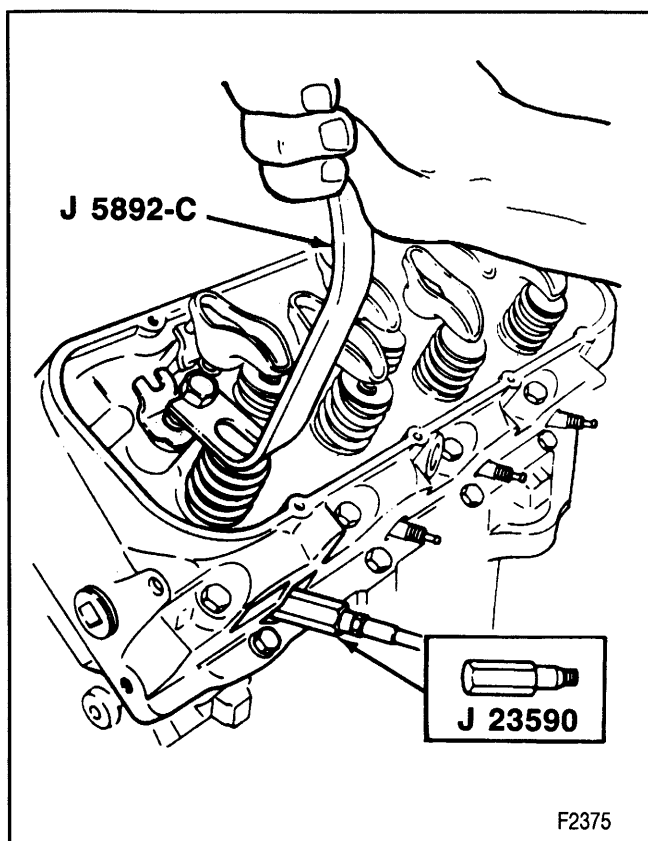


Figure 8—Compressing the Valve Spring

C. Carefully release spring pressure. Make sure the valve keepers stay in place.

D. Remove J 5892-C and J 23590.

4. Spark plugs. Refer to SECTION 6D4.

5. Rocker arms. Refer to "Rocker Arm and Pushrod Replacement."

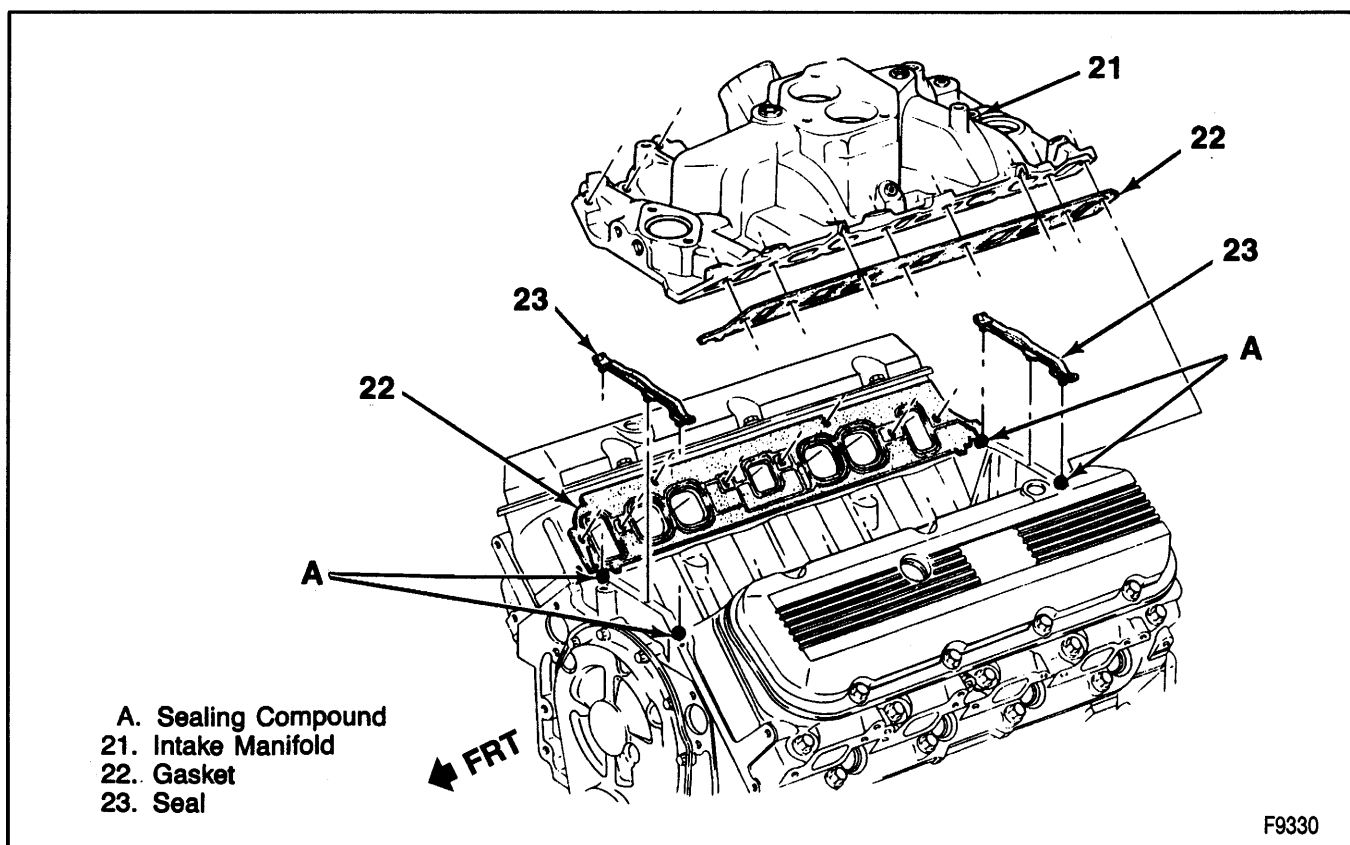
6. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

INTAKE MANIFOLD REPLACEMENT



Remove or Disconnect (Figures 9 and 10)

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
 - Drain the cooling system.
3. Upper radiator hose and coolant pump bypass hose.
4. Heater hose and pipe.
5. Sensor wire at front of intake manifold.
6. Accelerator and cruise control cables (if equipped).
7. Wiring harness from clips, and move aside.
8. Fuel lines at TBI unit.
9. Crankcase ventilation hoses.
10. Vacuum hoses, as necessary.
11. Distributor. Refer to SECTION 6D4.
12. Ignition coil wires.
13. Sensors with bracket on right side.
14. Air conditioning compressor rear bracket (if equipped).
15. Generator right rear bracket.



- A. Sealing Compound
- 21. Intake Manifold
- 22. Gasket
- 23. Seal

Figure 9—Intake Manifold

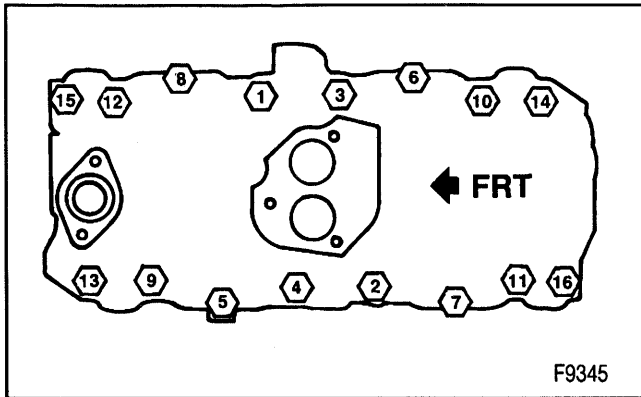


Figure 10—Intake Manifold Tightening Sequence

- 16. Intake manifold bolts.
- 17. Intake manifold (21).
- 18. Gaskets (22) and seals (23).



Clean

- Old gaskets (22) and seals (23) from the block, heads, and intake manifold.
- Excessive carbon deposits from the exhaust and EGR passages.
- Excessive scale and deposits from the coolant passages.



Inspect

- Manifold for cracks and gasket surface damage.



Install or Connect (Figures 9 and 10)

1. Front and rear intake manifold seals (23) to the block.
2. Side gaskets (22) to the cylinder heads.
 - Apply a 5-mm (3/16-inch) spot of RTV sealer (GM part number 1052289 or equivalent) to the front and rear of the block in four places as shown in figure 9.

NOTICE: Refer to "Notice" on page 6A5-1.

3. Intake manifold (21) and bolts.



Tighten

- Bolts to 40 N.m (30 lbs. ft.). Use the tightening sequence shown in figure 10.

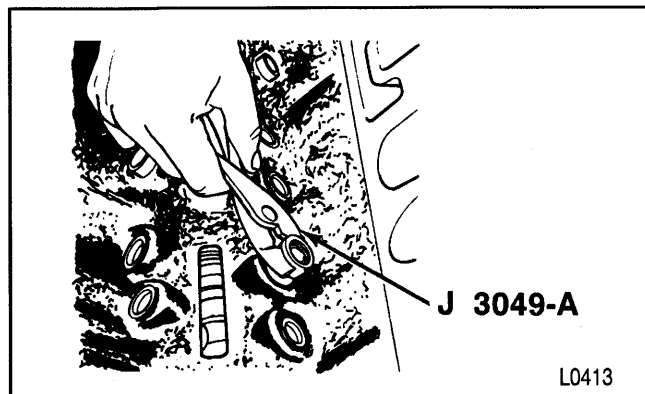


Figure 11—Removing the Valve Lifter

4. Generator bracket.
5. Sensors with bracket.
6. Ignition coil wires.
7. Distributor. Refer to SECTION 6D4.
8. Vacuum hoses.
9. Crankcase ventilation hoses.
10. Fuel lines.
11. Wiring harnesses to the clips.
12. Accelerator and cruise control cables (if equipped).
13. Sensor wire at front of manifold.
14. Heater hose and pipe.
15. Coolant pump bypass hose and upper radiator hose.
16. Air cleaner.
17. Negative battery cable.
 - Fill the cooling system with the proper quantity and grade of coolant, refer to SECTION 6B1.
 - Check for leaks.

HYDRAULIC LIFTER REPLACEMENT



Remove or Disconnect (Figures 11 and 12)

Tools Required:

- J 3049-A Lifter Remover (Plier Type) or
- J 9290-01 Lifter Remover (Slide Hammer Type)
- 1. Rocker arm cover, intake manifold, and pushrod.
- 2. Hydraulic lifters.
 - Remove the hydraulic lifters one at a time and place them in an organizer rack. The lifters must be installed in the same bore from which they were removed.
 - A stuck hydraulic lifter can be removed using J 3049-A (figure 11) or J 9290-01 (figure 12).



Inspect

- Hydraulic lifter body for scuffing and scoring. If the lifter body wall is worn or damaged, the mating bore in the block should also be checked.
- Check the fit of each hydraulic lifter in its mating bore in the block. If the clearance is excessive, try a new lifter.

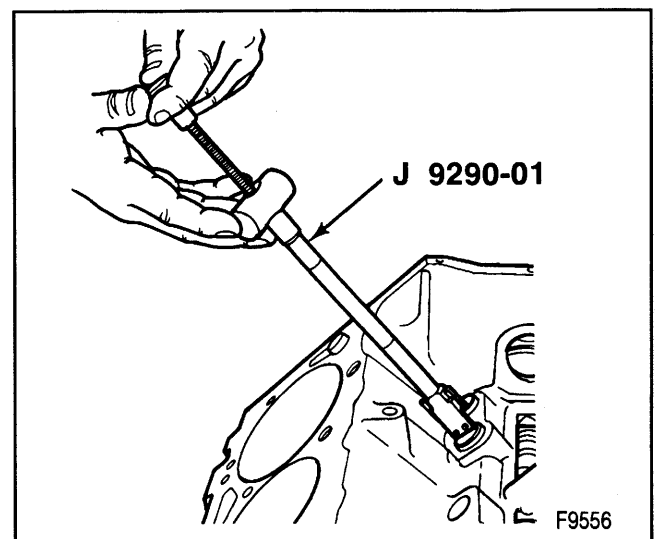


Figure 12—Removing the Valve Lifter

- The hydraulic lifter foot must be smooth and slightly convex. If worn, pitted, or damaged, the mating camshaft lobe should also be checked.

HYDRAULIC LIFTER REPAIR

- Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual.



Install or Connect

1. Hydraulic lifters to the block. Lubricate the lifter foot and body with High Viscosity Oil with zinc (GM P/N 12345501) or equivalent.



Important

- When any new hydraulic lifters or a new camshaft is installed, replace the engine oil and filter. High viscosity oil with zinc (GM P/N 12345501) or equivalent should be added to the crankcase oil.
 - Replace all hydraulic lifters when a new camshaft is installed.
2. Intake manifold. "Refer to Intake Manifold Replacement."
 3. Pushrod.
 4. Rocker arm, ball, and bolt.
 5. Rocker arm cover.

EXHAUST MANIFOLD REPLACEMENT



Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
2. Heat stove pipe (right side manifold).
3. Dipstick tube (right side manifold).
4. Oxygen sensor wire (left side manifold). Do not remove the sensor unless it is to be replaced.
5. AIR hose at the check valve.
6. Spark plugs.
7. Exhaust pipe at the manifold.
8. Exhaust manifold bolts and spark plug heat shields.
9. Exhaust manifold.

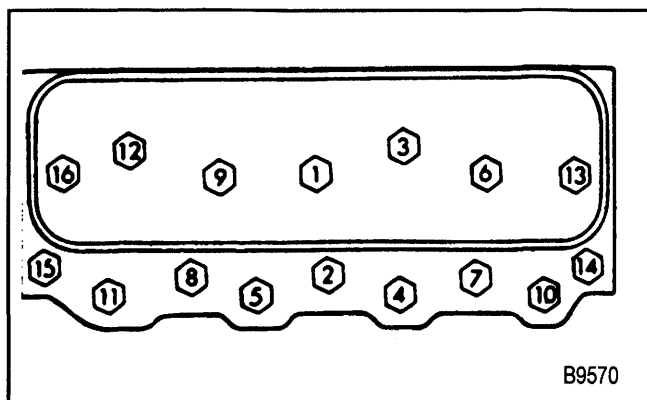


Figure 13—Cylinder Head Bolt Tightening Sequence



Clean

- Mating surfaces on the manifold and head.
- Threads on the exhaust manifold bolts.



Install or Connect

1. Exhaust manifold.

NOTICE: Refer to "Notice" on page 6A5-1.

2. Exhaust manifold bolts and spark plug shields.



Tighten

- Exhaust manifold bolts to 54 N.m (40 lbs. ft.). Tighten the center bolts first, then continue outward each way.
3. Exhaust pipe.
 4. Spark plugs. Refer to SECTION 6D4.
 5. AIR hose.
 6. Oxygen sensor wire (left side manifold).
 7. Dipstick tube (right side manifold).
 8. Heat stove pipe (right side manifold).
 9. Negative battery cable.

CYLINDER HEAD REPLACEMENT



Remove or Disconnect

1. Intake manifold. Refer to "Intake Manifold Replacement."
2. Air conditioning compressor and bracket and lay aside (right cylinder head).
3. AIR pump and bracket (right cylinder head).
4. Generator with brackets (left cylinder head).
5. Power steering pump with brackets, and lay aside (left cylinder head).
6. Exhaust manifold. Refer to "Exhaust Manifold Replacement."
7. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
8. Spark plugs.
9. AIR pipe bolts at rear of cylinder head. Push the pipe out of the way.
10. Ground strap at the rear of the cylinder head.
11. Sensor wire at the cylinder head.
12. Pushrods.
13. Cylinder head bolts.
14. Cylinder head.
15. Head gasket.



Clean

- Carbon deposits from combustion chambers.
- All traces of old head gasket from cylinder head and block.
- Cylinder head bolt threads and threads in the block.



Inspect

- Sealing surfaces of the block and cylinder head for nicks, heavy scratches, or other damage.

CYLINDER HEAD REPAIR

- Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual.

Install or Connect

1. Head gasket.
 - Do not use sealer on composition gaskets.
 - Place the gasket over the block dowel pins with the bead up.
2. Cylinder head. Carefully guide the cylinder head into place over the dowel pins and gasket.

NOTICE: Refer to "Notice" on page 6A5-1.

3. Cylinder head bolts. Coat threads of the cylinder head bolts with sealing compound (GM P/N 1052080 or equivalent) and install finger-tight.

Tighten

- Cylinder head bolts in three steps using the sequence shown in figure 13.
 - The first sequence to 40 N.m (30 lbs. ft.).
 - The second sequence to 80 N.m (60 ft. lbs.).
 - The final torque sequence to 110 N.m (80 lbs. ft.).
4. Pushrods.
 5. Rocker arms, balls, and bolts.
 6. Sensor wire.
 7. Ground strap at the rear of the cylinder head.
 8. A.I.R pipe to the rear of the cylinder head.
 9. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
 10. Spark plugs. Refer to SECTION 6D4.
 11. Exhaust manifold. Refer to "Exhaust Manifold Replacement."
 12. Power steering pump with brackets (left cylinder head).
 13. Generator with brackets (left cylinder head).
 14. A.I.R pump and brackets (right cylinder head).
 15. Air conditioning compressor and brackets (right cylinder head).
 16. Intake manifold. Refer to "Intake Manifold Replacement."

TORSIONAL DAMPER AND CRANKSHAFT FRONT SEAL REPLACEMENT

Remove or Disconnect (Figure 14)

Tool Required:

J 39046 Torsional Damper Puller and Installer

1. Negative battery cable. Refer to SECTION 0A.
2. Multiple ribbed belt, fan, and pulley.
3. Fan shroud assembly.
4. Accessory drive pulley.
5. Torsional damper pulley.
6. Torsional damper. Use J 39046 (figure 14).
7. Crankshaft front seal. Pry out with a large screwdriver. Take care not to distort the front cover.

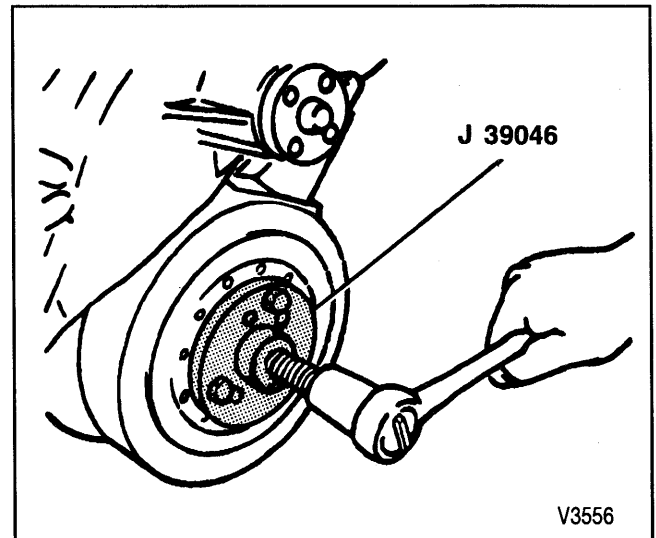


Figure 14—Removing the Torsional Damper

8. Crankshaft key, if necessary.

Inspect

- Oil seal contact area on the torsional damper shaft for grooving and roughness. Replace if necessary.

Install or Connect (Figures 15 and 16)

Tools Required:

J 22102 Seal Installer

J 39046 Torsional Damper Puller and Installer

1. Crankshaft key, if removed.
2. Crankshaft front seal. Use J 22102 (figure 15). The open end of the seal faces inside the engine. Coat the seal lips with engine oil.

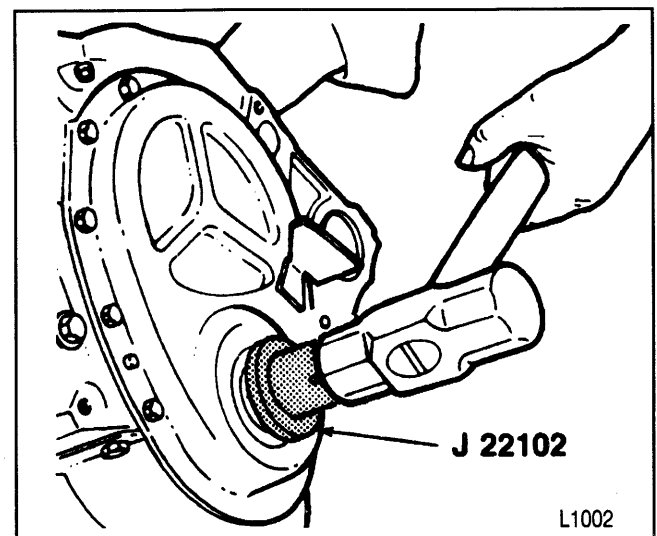


Figure 15—Installing the Crankshaft Front Seal

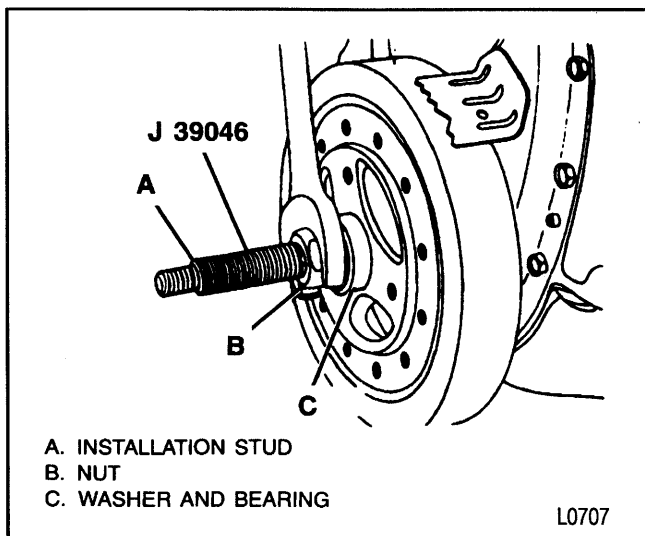


Figure 16—Installing the Torsional Damper

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber-type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the torsional damper.

3. Stud (item A, figure 16) to the crankshaft. Thread the stud fully into the tapped hole in the crankshaft.
4. Torsional damper over the end of the stud. Align the keyway in the torsional damper shaft with the crankshaft key.
 - Use a small amount of RTV sealer to seal the crankshaft key to crankshaft joint.
5. Bearing, washer, and nut (figure 16).
 - Turn the nut to pull the vibration damper into place.
 - Remove the tool.

NOTICE: Refer to "Notice" on page 6A5-1.

6. Torsional damper bolt and washer.



Tighten

- Bolt to 115 N-m (85 lbs. ft.).
7. Accessory drive pulley.
 8. Fan shroud assembly.
 9. Fan pulley, fan, and belt.
 10. Negative battery cable.

FRONT COVER REPLACEMENT



Remove or Disconnect (Figure 17)

1. Torsional damper. Refer to "Torsional Damper and Front Cover Replacement."
2. Coolant pump. Refer to SECTION 6B1.
3. Oil pan. Refer to "Oil Pan Replacement."
4. Front cover bolts (93).
5. Front cover (91).
6. Front cover to block gasket (90).

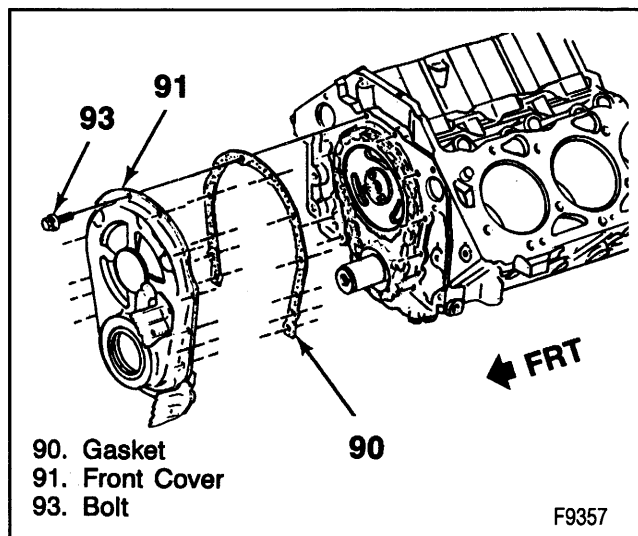


Figure 17—Front Cover

7. Crankshaft front seal from the front cover. Pry out with a screwdriver. Take care not to distort the front cover.



Clean

- Old gasket (90) from the front cover and block.



Inspect

- Front cover (91) for distortion and damage. Replace if necessary.



Install or Connect (Figures 15 and 17)

Tools Required:

J 22102 Seal Installer

1. Crankshaft front seal. Use J 22102 (figure 15). The open end of the seal faces inside the engine. Coat the seal lips with engine oil.
2. Front cover gasket (90) to the front cover (91). Use gasket cement to hold it in place.

NOTICE: Refer to "Notice" on page 6A5-1.

3. Front cover (91) and bolts (93) to the engine.



Tighten

- Front cover to block bolts (93) to 11 N-m (100 lbs. in.).
4. Oil pan, as outlined later in this section.
 5. Coolant pump. Refer to SECTION 6B1.
 6. Torsional damper. Refer to "Torsional Damper and Crankshaft Front Seal Replacement."

OIL PAN REPLACEMENT



Remove or Disconnect (Figure 18)

1. Negative battery cable. Refer to SECTION 0A.
2. Fan shroud from the radiator and push rearward.
3. Air cleaner.

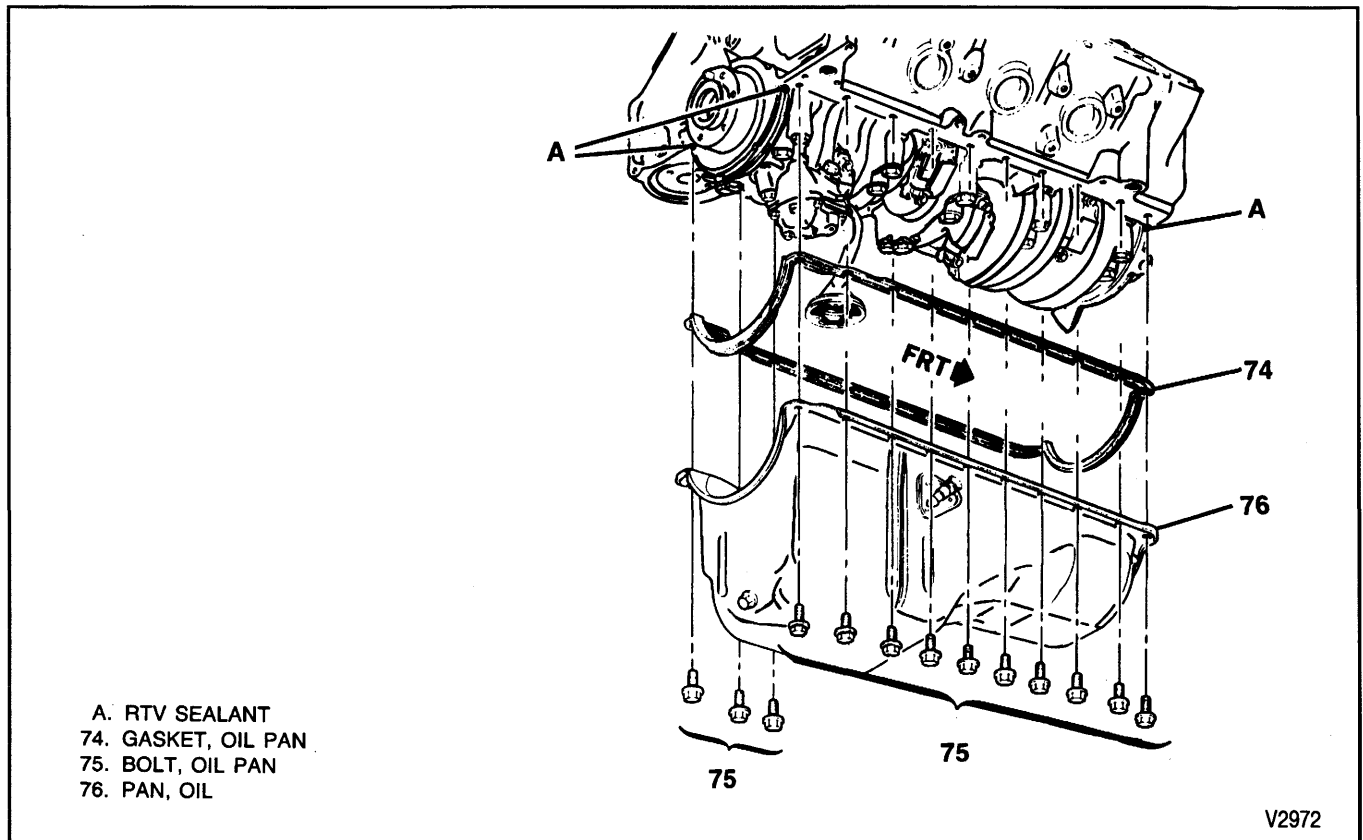


Figure 18—Oil Pan and Components

4. Distributor cap.
- Raise the vehicle. Support with safety stands.
- Drain the engine oil.
5. Starter (vehicles with manual transmission).
6. Torque converter or clutch cover.
7. Oil filter.

NOTICE: Oil pressure line must be removed from the side of the block to prevent crushing of the line when the engine is raised.

8. Oil pressure line from the side of the block.

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the engine with a suitable lifting fixture.
- 9. Engine mounting through-bolts.
- Raise the engine only enough to permit oil pan removal.
- 10. Oil pan bolts (75).
- 11. Oil pan (76).
- 12. Gasket (74).



Clean

- Gasket surfaces on the engine and oil pan.



Install or Connect (Figure 18)

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A5-1.

- Apply RTV sealer (GM P/N 1052080 or equivalent) to the front and rear corners of the gasket as shown in figure 18.
- 1. Oil pan gasket (74) to the oil pan (76).
- 2. Oil pan (76) to the engine.
- 3. Oil pan bolts (75).



Tighten

- Oil pan to block bolts (75) to 18 N·m (13 lbs. ft.).
- Lower the engine.
- 4. Engine mounting through bolts.



Tighten

- Through-bolts to specifications. Refer to figures 32, 33, and 34.
- 5. Oil pressure line.
- 6. Oil filter.
- 7. Torque converter or clutch cover.
- 8. Starter (if removed).
- Lower the vehicle.
- 9. Distributor cap.
- 10. Air cleaner.
- 11. Fan shroud.
- 12. Proper quantity and grade of engine oil.
- 13. Negative battery cable.

OIL PUMP REPLACEMENT

Remove or Disconnect

1. Oil pan. Refer to "Oil Pan Replacement."
2. Oil pump to main bearing cap bolt.
3. Oil pump.

Inspect

- Oil pump pickup tube and screen for damage and looseness. If the tube is loose or damaged, the oil pump must be replaced. The pickup tube and screen are not serviced separately.

OIL PUMP REPAIR

- Refer to SECTION 6A5 the Light Duty Truck Unit Repair Manual.

Install or Connect

1. Oil pump to the engine. Align the slot in the oil pump shaft with the tang on the distributor shaft. The oil pump should slide easily into place. No gasket is used.

NOTICE: Refer to "Notice" on page 6A5-1.

2. Oil pump to main bearing cap bolt.

Tighten

- Oil pump bolt to 90 N.m (65 lbs. ft.).
3. Oil pan. Refer to "Oil Pan Replacement."

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Remove or Disconnect

1. Transmission. Refer to SECTION 7.
2. Clutch and flywheel or flexplate, as equipped.

NOTICE: When removing the rear crankshaft oil seal be careful not to nick the crankshaft sealing surface.

3. Crankshaft rear oil seal. Use care not to damage the crankshaft seal surface.

Inspect

- Chamfer on crankshaft for grit, loose rust, and burrs. Correct as necessary.

Clean

- Seal running surface on the crankshaft with a non-abrasive cleaner.

Install or Connect (Figure 19)

Tool Required:
J 38841 Seal Installer

1. Crankshaft rear oil seal.
 - A. Lubricate the inner and outer diameter of the seal with engine oil.
 - B. Install the seal on J 38841.

- C. Position J 38841 against the crankshaft. Thread the attaching screws into the tapped holes in the crankshaft.
- D. Tighten the screws securely with a screwdriver. This will ensure that the seal is installed squarely over the crankshaft.
- E. Turn the handle until it bottoms.
- F. Remove J 38841.

2. Clutch and flywheel or flexplate, as equipped.
3. Transmission. Refer to SECTION 7.

MEASURING CAMSHAFT LOBE LIFT

Tools Required:

J 8520 Camshaft Lobe Lift Indicator

1. Remove the rocker arm. Refer to "Rocker Arm and Pushrod Replacement."
2. Position the dial indicator (part of J 8520) so the plunger rests on the pushrod end, as shown in figure 20. Make sure the pushrod is in the lifter socket.

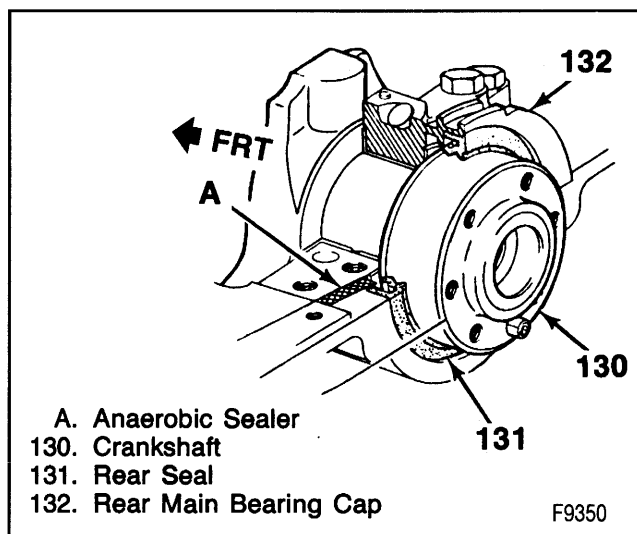


Figure 19—Applying Sealer to the Block

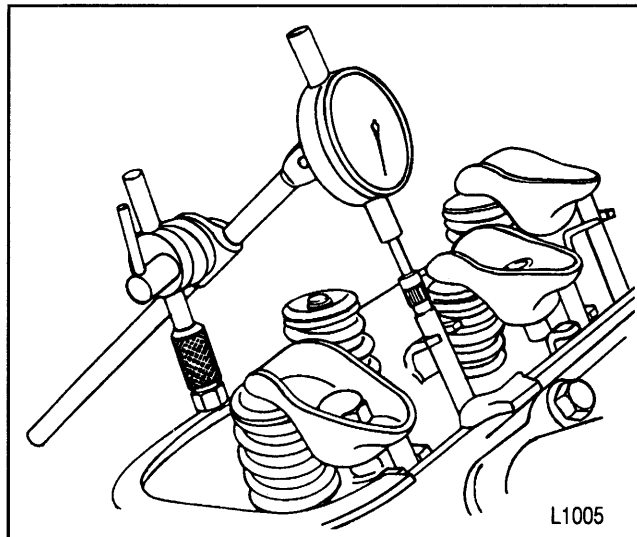


Figure 20—Measuring Camshaft Lobe Lift

3. Rotate the crankshaft slowly in the direction of rotation until the lifter is on the heel of the cam lobe. At this point, the pushrod will be in its lowest position.
4. Set the dial indicator on zero, then rotate the crankshaft slowly, or attach an auxiliary starter switch and "bump" the engine over, until the pushrod is in fully raised position.

! Important

- Whenever the engine is cranked remotely at the starter, with a special jumper cable or other means, the primary leads should be disconnected from the distributor or ignition coil.
5. Compare the total lift recorded from the dial indicator with specifications.
 6. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
 7. Install the rocker arm, ball, and bolt. Refer to "Rocker Arm and Pushrod Replacement."

CAMSHAFT REPLACEMENT

↔ Remove or Disconnect (Figures 21, 22, and 23)

Tool Required:

J 28509-A Crankshaft Sprocket Puller

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner.
3. Grille.
4. Air conditioning condenser from its mounting and swing it forward.
5. Fan, shroud, and radiator. Refer to SECTIONS 6B1 and 6B2.
6. Generator and bracket.
7. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
8. Coolant pump. Refer to SECTION 6B1.
9. Torsional damper. Refer to "Torsional Damper and Crankshaft Front Seal Replacement."
10. Front cover. Refer to "Front Cover Replacement."
11. Distributor. Refer to SECTION 6D4.

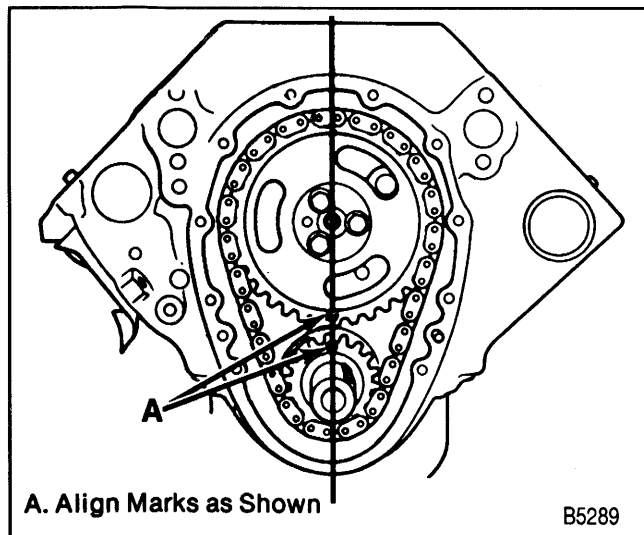


Figure 21—Timing Marks

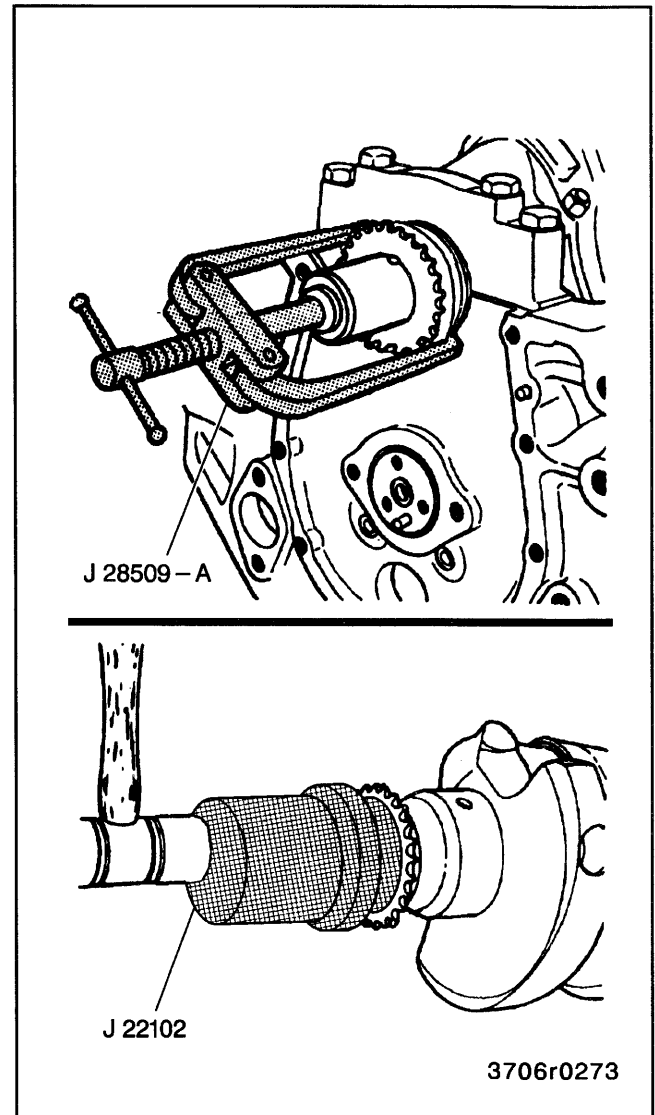


Figure 22—Replacing the Crankshaft Sprocket

12. Intake manifold. Refer to "Intake Manifold Replacement."
13. Pushrods and hydraulic lifters. Refer to "Rocker Arm and Pushrod Replacement."
 - Align the timing marks (figure 21).
14. Camshaft sprocket bolts.
15. Camshaft sprocket and timing chain. The sprocket is a light interference fit on the camshaft. Tap the sprocket on its lower edge to loosen it.
16. Crankshaft sprocket (if required). Use J 28509-A (figure 22).
17. Camshaft.
 - Install two or three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft threaded holes. Use these bolts to handle the camshaft (figure 23).
 - Pull the camshaft from the block. Use care to prevent damage to the camshaft bearings.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the camshaft and related components, as outlined in SECTION 6A5 of the Light Duty Truck Unit Repair Manual.

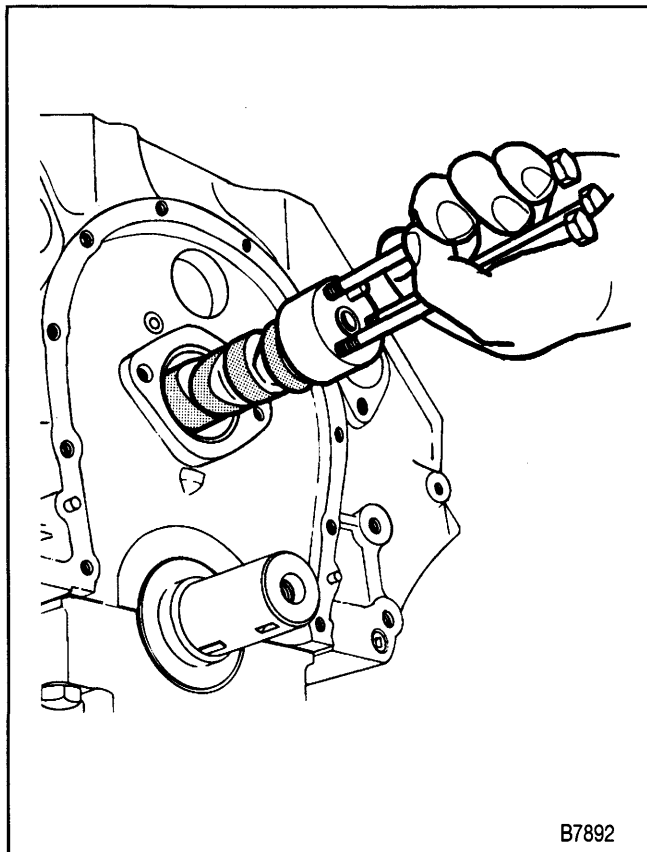


Figure 23—Replacing the Camshaft

The unit repair manual also describes camshaft bearing replacement.

→→ Install or Connect (Figures 21, 22, and 23)

Tool Required:

J 22102 Crankshaft Sprocket Installer

- Coat the camshaft lobes and journals with high viscosity oil with zinc (GM P/N 12345501) or equivalent.
- 1. Two or three 5/16-18 bolts 100-125 mm (4-5 inches) long into the camshaft threaded holes. Use these bolts to handle the camshaft.
- 2. Camshaft in the engine (figure 23). Handle the camshaft carefully to prevent damage to the camshaft bearings.
- 3. Crankshaft sprocket (if removed). Use J 22102 (figure 22). Make sure the timing mark faces outside.
- 4. Camshaft sprocket and timing chain.

! Important

- Line up the timing marks on the camshaft sprocket and crankshaft sprocket (figure 21).

NOTICE: Refer to "Notice" on page 6A5-1.

5. Camshaft sprocket bolts.

⌚ Tighten

- Bolts to 27 N·m (20 lbs. ft.).
- 6. Hydraulic lifters and pushrods, and rocker arms. Refer to "Hydraulic Lifter Replacement."

! Important

- Replace all hydraulic lifters, crankcase oil and filter. Add High Viscosity Oil with zinc (GM P/N 12345501) or equivalent to the engine oil any time a new camshaft is installed.
- 7. Intake manifold. Refer to "Intake Manifold Replacement."
- 8. Distributor. Refer to SECTION 6D4.
- 9. Front cover, as outlined previously.
- 10. Torsional damper. Refer to "Torsional Damper and Front Cover Seal Replacement."
- 11. Coolant pump. Refer to SECTION 6B1.
- 12. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
- 13. Generator and bracket.
- 14. Fan, shroud, and radiator. Refer to SECTIONS 6B1 and 6B2.
- 15. Air conditioning condenser.
- 16. Grille.
- 17. Air cleaner.
- 18. Negative battery cable.
- Fill the cooling system with the proper quantity and grade of coolant. Refer to SECTION 0B.
- Check for leaks.

CONNECTING ROD AND PISTON REPLACEMENT

↔ Remove or Disconnect (Figure 24)

Tool Required:

J 5239 Guide Set

1. Cylinder head. Refer to "Cylinder Head Replacement."
2. Oil pan. Refer to "Oil Pan Replacement."
3. Oil pump. Refer to "Oil Pump Replacement."
4. Ridge or deposits from the upper end of the cylinder bores.
 - A. Turn the crankshaft until the piston is at BDC.
 - B. Place a cloth on top of the piston.
 - C. Perform the cutting operation with a ridge reamer.
 - D. Turn the crankshaft until the piston is at TDC.
 - E. Remove the cloth and cuttings.
5. Connecting rod cap. Check the connecting rod and cap for identification marks. Mark the parts if required. The connecting rod and cap must be kept together as mating parts.
6. Connecting rod and piston.
 - Attach J 5239 to the connecting rod bolts (figure 24).
 - Use the long guide rod of J 5239 to push the connecting rod and piston out of the bore.
7. Connecting rod bearing.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the components as necessary. Measure connecting rod bearing clearance, piston clearance, ring clearances, etc. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual.

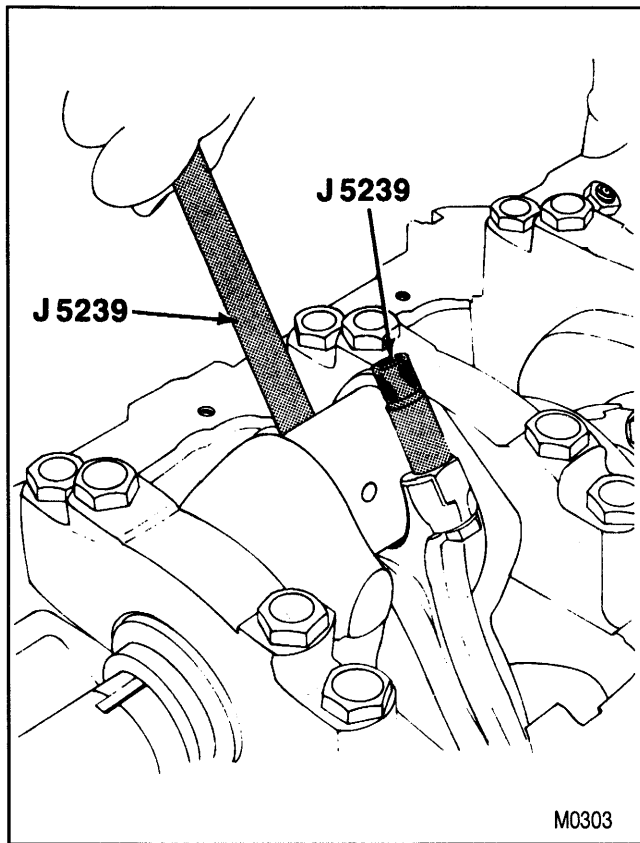


Figure 24—Replacing the Connecting Rod and Piston

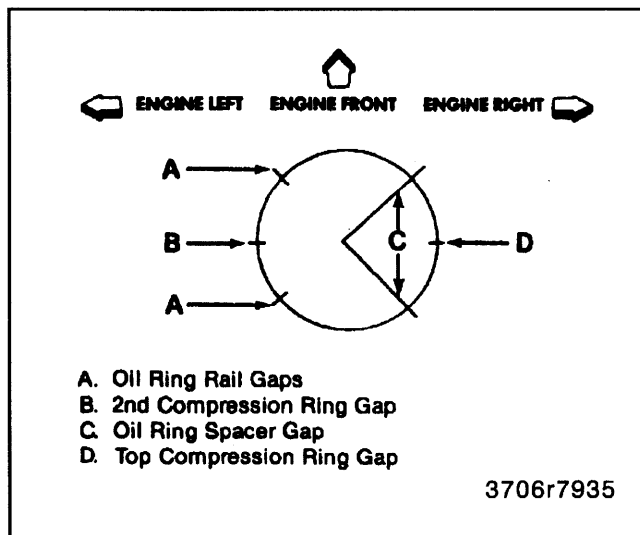


Figure 25—Ring End Gap Location

The unit repair manual contains information on:

- Connecting rod and piston.
- Piston rings.
- Connecting rod and crankpin.
- Cylinder bores.



Install or Connect (Figures 24 through 29)

Tools Required:

- J 5239 Connecting Rod Guide Set
- J 8037 Ring Compressor

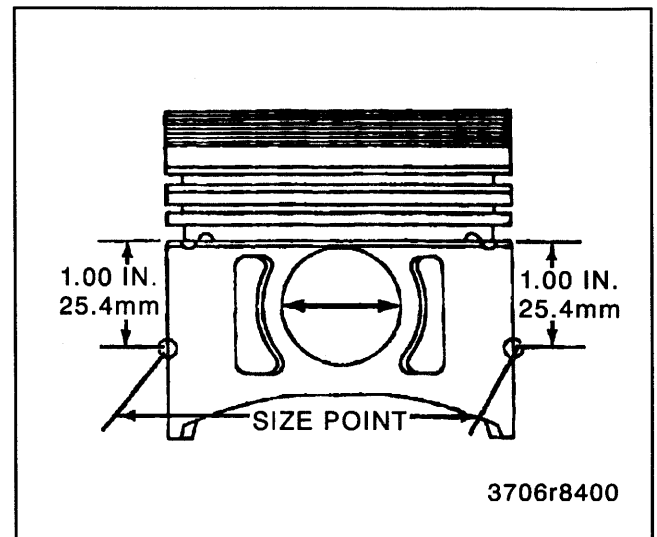


Figure 26—Measuring the Piston Diameter

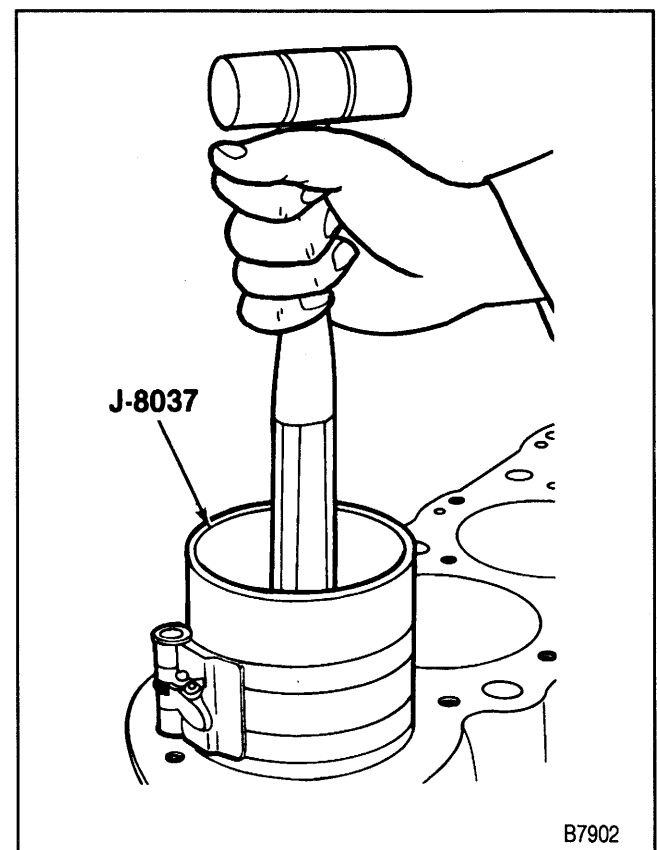


Figure 27—Installing the Piston

- Make sure the cylinder walls are clean. Lubricate the cylinder wall lightly with engine oil.
- Make sure the piston is installed in the matching cylinder for which it was fitted. Used pistons must be installed in the cylinder they were removed from.

1. Connecting rod bearings.

- Make sure the bearings are the proper size.
- Install the bearings in the connecting rod and connecting rod cap.
- Lubricate the bearings with engine oil.

2. Piston and connecting rod to the proper bore.

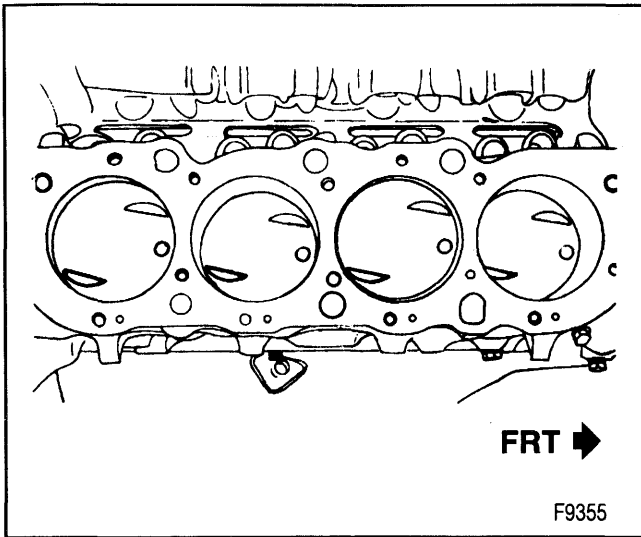


Figure 28—Piston Installed

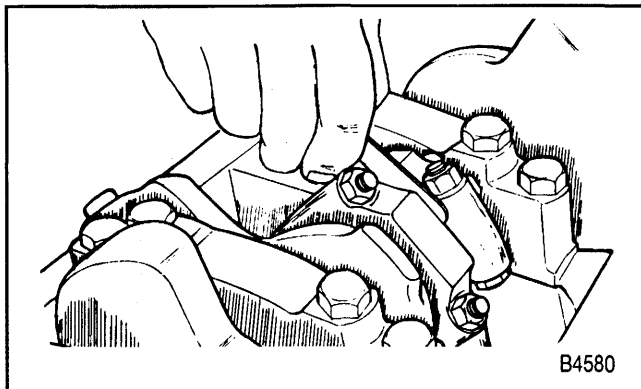


Figure 29—Measuring Connecting Rod Side Clearance

- With the connecting rod cap removed, install J 5239 onto the connecting rod bolts.
- Locate the piston ring end gaps as shown in figure 25. Lubricate the piston and rings with engine oil.
- Without disturbing the ring end gap location, install J 8037 over the piston (figure 27).
- The piston must be installed so that the dimple faces the front of the engine (figure 28).
- Place the piston in its matching bore. Using light blows with a hammer handle, tap the piston down into its bore (figure 27). At the same time, from beneath the vehicle, guide the connecting rod to the crankpin with J 5239 (figure 24). Hold the ring compressor against the block until all rings have entered the cylinder bore.
- Remove J 5239 from the connecting rod bolts.

! Important

- Each connecting rod and bearing cap should be marked, beginning at the front of the engine. Cylinders 1, 3, 5, and 7 are the left bank and 2, 4, 6, and 8 are the right bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed

from one block or cylinder to another, new connecting rod bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

Measure

- Connecting rod bearing clearance. Refer to SECTION 6A of the Light Duty Unit Repair Manual.

3. Connecting rod cap and bearing.

NOTICE: Refer to "Notice" on page 6A5-1.

4. Connecting rod bolt nuts.

Tighten

- Connecting rod bolt nuts to 66 N·m (48 lbs. ft.).

Measure

- Connecting rod side clearance. Use a feeler gage between the connecting rod and crankshaft (figure 29). The correct clearance is 0.013-0.023 inch.
- Oil pump (if removed). Refer to "Oil Pump Replacement."
 - Oil pan and cylinder head. Refer to "Oil Pan Replacement" and "Cylinder Head Replacement."

MAIN BEARING REPLACEMENT

Remove or Disconnect (Figure 30)

Tool Required:

J 8080 Main Bearing Remover/Installer

- Spark plugs.
- Oil pan. Refer to "Oil Pan Replacement."
- Oil pump. Refer to "Oil Pump Replacement."
- Main bearing caps.
 - Check the main bearing caps for location markings. Mark the caps if necessary. The caps must be returned to their original locations during assembly.

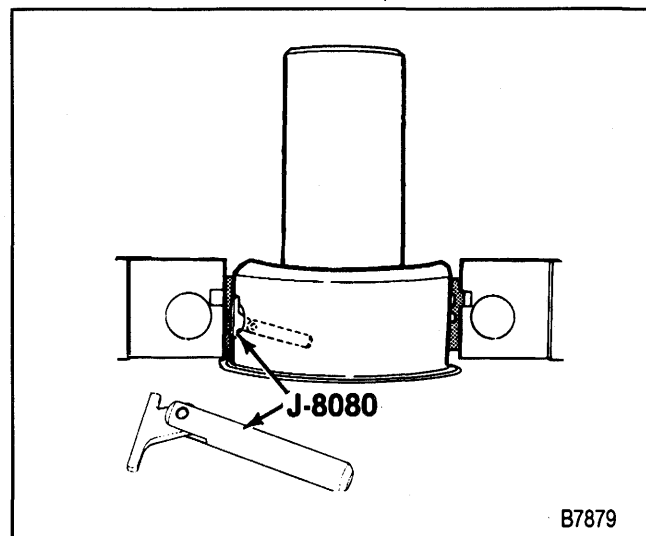


Figure 30—Removing the Main Bearing

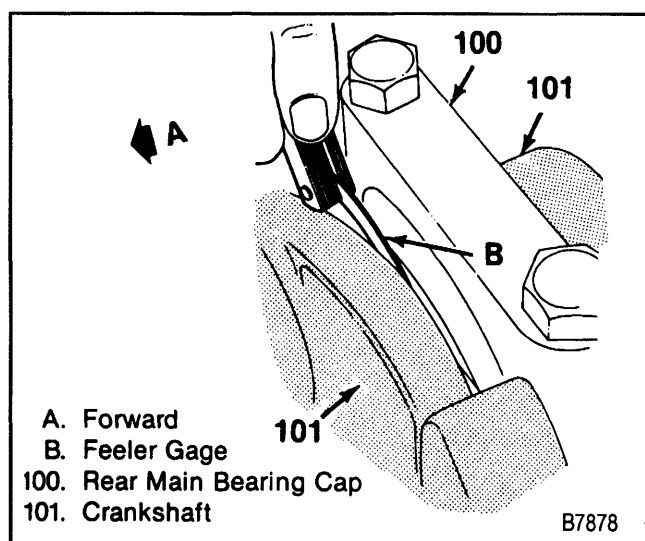


Figure 31—Measuring Crankshaft End Play

5. Lower main bearing inserts from the main bearing caps.
6. Crankshaft rear oil seal, if necessary. Refer to "Crankshaft Rear Oil Seal Replacement."
7. Upper main bearing inserts.

- Insert J 8080 into the crankshaft oil hole (figure 30).
- Rotate the crankshaft to "turn" the bearing insert out of the block.

Cleaning, Inspection, and Repair

Clean, inspect, and repair or replace the components as required. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual. The unit repair manual contains information on:

- Crankshaft.
- Main and connecting rod bearings.

Install or Connect (Figures 30 and 31)

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A5-1.

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Upper main bearing inserts.
 - A. Insert tool J 8080 into a crankshaft main bearing oil hole (figure 30).
 - B. Apply engine oil to inserts of the proper size.
 - C. Insert the plain end (without the bearing tang) of the insert between the crankshaft and the notched side of the block.
 - D. Rotate the crankshaft to "roll" the insert into the block.
 - E. Remove the tool.
2. Lower main bearing inserts to the main bearing caps.
 - Make sure the inserts are of the proper size.
 - Apply engine oil to the inserts.

Measure

- Main bearing clearance. Refer to SECTION 6A of the Light Duty Truck Unit Repair Manual. If the engine is in the vehicle, the crankshaft must be supported upward to remove any clearance from the upper bearing. The total clearance can then be measured between the lower bearing and journal.

3. Main bearing caps (except rear cap) and bolts to the block.

Tighten

- Main bearing cap bolts to 135 N·m (100 lbs. ft.).
4. Rear main bearing cap.

- A. Apply a brush-on type oil sealing compound to the mating surface of the block and cap (figure 19). Do not allow any sealant on either crankshaft or rear oil seal.
- B. Apply engine oil to the bearing insert.
- C. Install the rear main bearing cap and bolts. Tighten the bolts temporarily to 14 N·m (10 lbs. ft.).

Measure

- Crankshaft end play, as follows:
 - a. Tap the end of the crankshaft first rearward then forward with a lead hammer. This will line up the rear main bearing and crankshaft thrust surfaces.
 - b. Tighten the rear main bearing cap bolts to 135 N·m (100 lbs. ft.).
 - c. With the crankshaft forced forward, measure at the front end of the rear main bearing with a feeler gage (figure 31). The proper clearance is 0.005-0.011 inch.

5. Oil pump. Refer to "Oil Pump Replacement."
6. Oil pan. Refer to "Oil Pan Replacement."
7. Spark plugs. Refer to SECTION 6D4.

CRANKSHAFT REPLACEMENT

1. Remove the engine. Refer to "Engine Replacement."
2. Refer to SECTION 6A5 of the Light Duty Truck Unit Repair Manual for crankshaft replacement procedures.

FLYWHEEL REPLACEMENT (AUTOMATIC AND MANUAL TRANSMISSIONS)

Remove or Disconnect (Figure 32)

1. Transmission, flywheel housing, and clutch. Refer to SECTION 7.
2. Flywheel bolts.
3. Flywheel.



Clean

- Mating surfaces of crankshaft and flywheel. Remove any burrs.



Inspect

- Flywheel for burning, scoring, warping, and wear. Replace the flywheel if necessary. Do not machine the flywheel.
- Flywheel ring gear for worn or broken teeth.

FLYWHEEL RING GEAR REPLACEMENT

1. Use a torch to heat the gear around the entire circumference, then drive the gear off the flywheel, using care not to damage the flywheel.

NOTICE: Never heat starter gear to red heat as this will change metal structure.

2. Uniformly heat the flywheel gear to a temperature which will expand the gear to permit installation. Temperature must not exceed 200°C (400°F).
3. As soon as the gear has been heated, install on the flywheel.



Install or Connect

1. Flywheel.

NOTICE: Refer to "Notice" on page 6A5-1.

2. Flywheel bolts.



Tighten

- Flywheel bolts to 90 N.m (65 lbs. ft.).
3. Clutch, flywheel housing, and transmission. Refer to SECTION 7.

ENGINE MOUNTINGS

NOTICE: Broken or deteriorated mountings can cause misalignment and eventual destruction of certain drive train components. When a single mounting breakage occurs, the remaining mountings are subjected to abnormally high stresses.

INSPECTING ENGINE MOUNTINGS

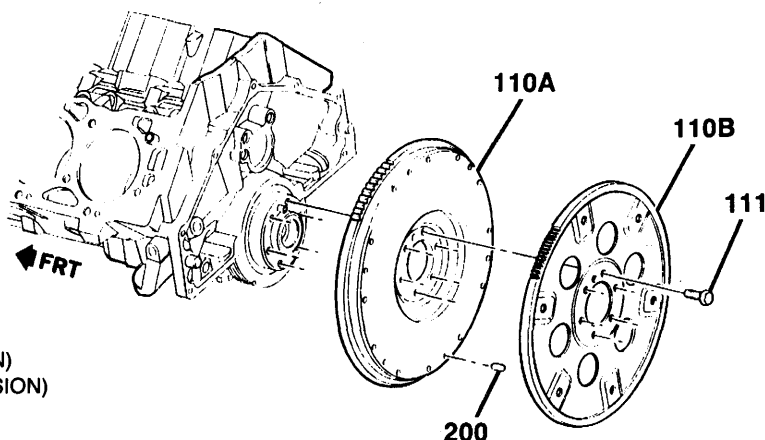
Front Engine Mountings

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

1. Raise the engine to remove the weight from the mountings and place a slight tension on the rubber cushion. Observe both mountings while raising the engine.
2. Replace the mounting if the following conditions exist:
 - Hard rubber surface covered with heat check cracks.
 - Rubber cushion separated from the metal plate of the mounting.
 - Rubber cushion split through the center.
3. If there is movement between a metal plate of the mounting and its attaching points, lower the engine and tighten the bolts or nuts attaching the mounting to the engine, frame, or bracket.

Rear Mountings

1. Push up and pull down on the transmission tailshaft. Observe the transmission mounting.
2. Replace the mounting if it is bottomed out (tailshaft can be moved up but not down).



- 110A. FLYWHEEL (MANUAL TRANSMISSION)
 110B. FLYWHEEL (AUTOMATIC TRANSMISSION)
 111. BOLT, FLYWHEEL
 200. PIN, ENGINE BALANCE GROOVE

V2973

Figure 32—Flywheel

3. If there is relative movement between a metal plate of the mounting and its attaching point, tighten the bolts or nuts attaching the mounting to the transmission or crossmember.

FRONT MOUNTING REPLACEMENT

- ↔ Remove or Disconnect (Figures 33, 34, and 35)

1. Negative battery cable. Refer to SECTION 0A.

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the engine with a suitable jack. Do not load the engine mounting.
2. Engine mounting through-bolt and nut.

NOTICE: Raise the engine only enough for sufficient clearance. Check for interference between the rear of the engine and the dash panel which could cause distributor damage.

- Raise the engine only enough to permit removal of the engine mounting.
3. Mounting assembly bolts, nuts, and washers.
 4. Mounting assembly.

- ↔ Install or Connect (Figures 33, 34, and 35)

NOTICE: For steps 2 and 3, refer to "Notice" on page 6A5-1.

1. Mounting assembly.

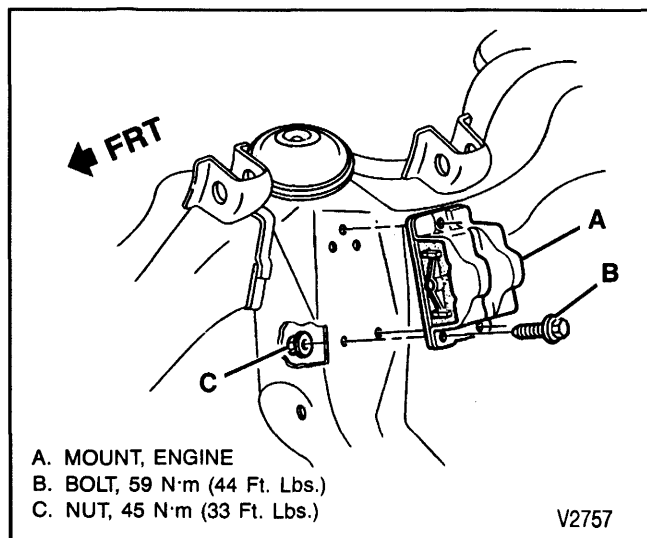


Figure 33—Front Engine Mounting Brackets to Frame (C-Models)

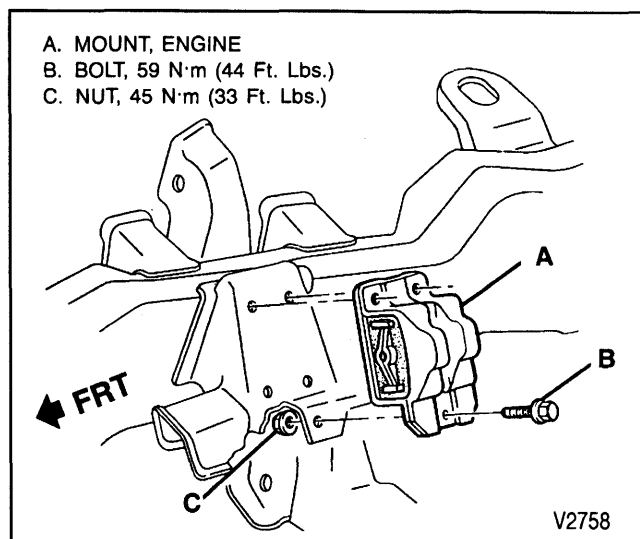


Figure 34—Front Engine Mounting Brackets to Frame (K-Models)

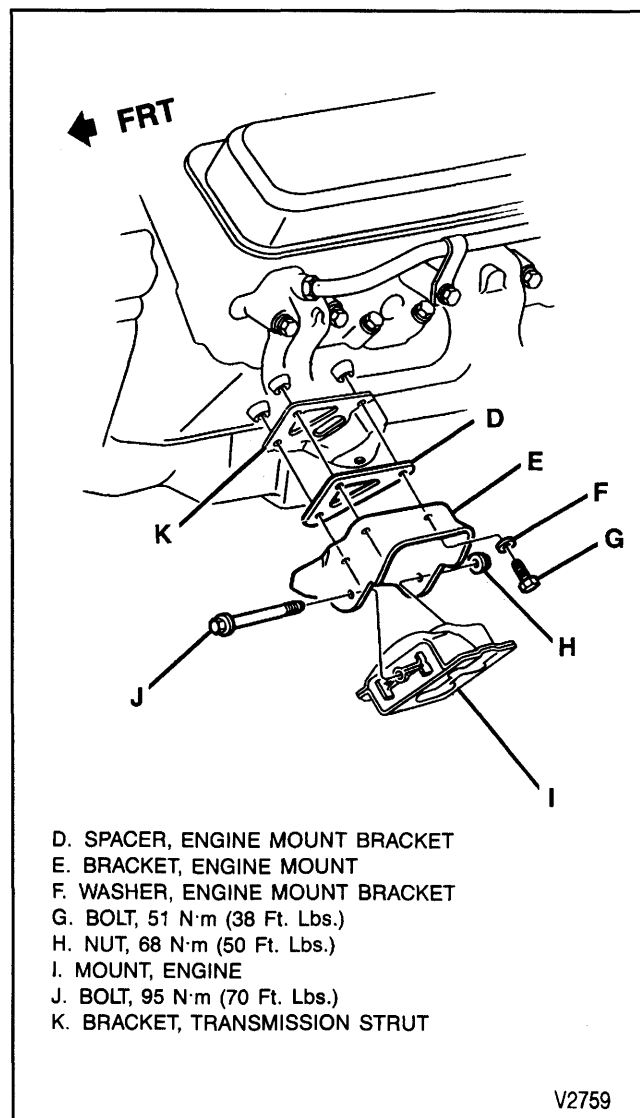


Figure 35—Front Engine Mounts to Brackets

2. Mounting assembly bolts, nuts, and washers.



Tighten

- Fasteners to specifications. Refer to figures 33, 34, and 35.
3. Engine mount through-bolt and nut. Lower the engine until the bolt can be inserted. Install the nut.



Tighten

- Through-bolt nut to specifications. Refer to figures 33, 34, and 35.
4. Negative battery cable.

REAR MOUNTING REPLACEMENT



Remove or Disconnect (Figures 36 and 37)

1. Negative battery cable. Refer to SECTION 0A.

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the rear of the engine to relieve the weight on the rear mountings.
2. Mounting to crossmember nut(s) and washer(s).

3. Mounting to transmission bolts and washers.

- Raise the rear of the engine only enough to permit removal of the mounting.

4. Mounting.



Install or Connect (Figures 36 and 37)

1. Mounting.

- Lower the rear of the engine.

2. Mounting to transmission bolts and washers.

NOTICE: Refer to "Notice" on page 6A5-1.

3. Mounting to crossmember nut(s) and washer(s).



Tighten

- Fasteners to specifications. Refer to figures 36 and 37.

4. Negative battery cable.

ENGINE REPLACEMENT



Remove or Disconnect

1. Hood.
2. Negative battery cable. Refer to SECTION 0A.
3. Air cleaner.
- Drain the cooling system. Refer to SECTION 6B1.
4. Radiator and fan shroud. Refer to SECTION 6B2.

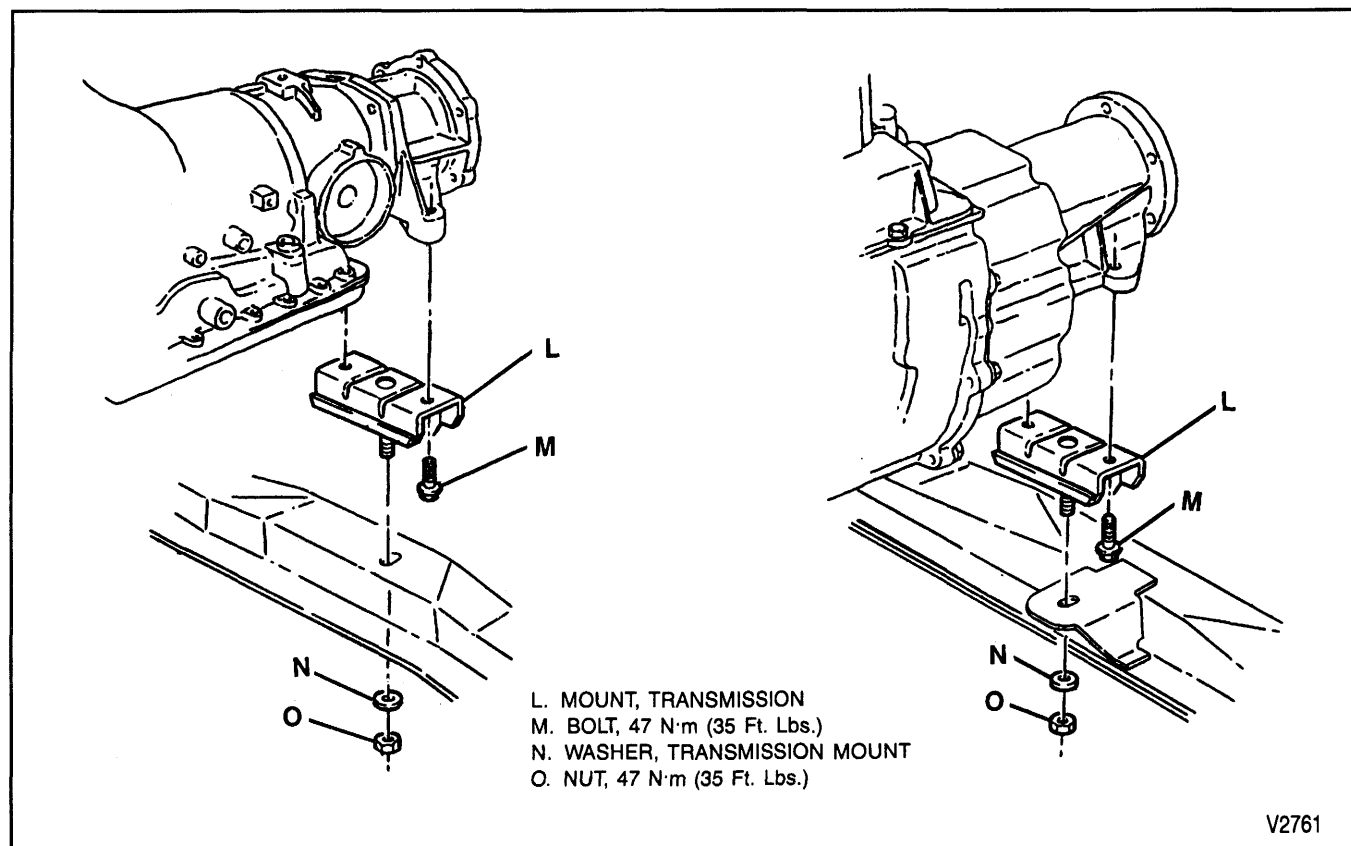
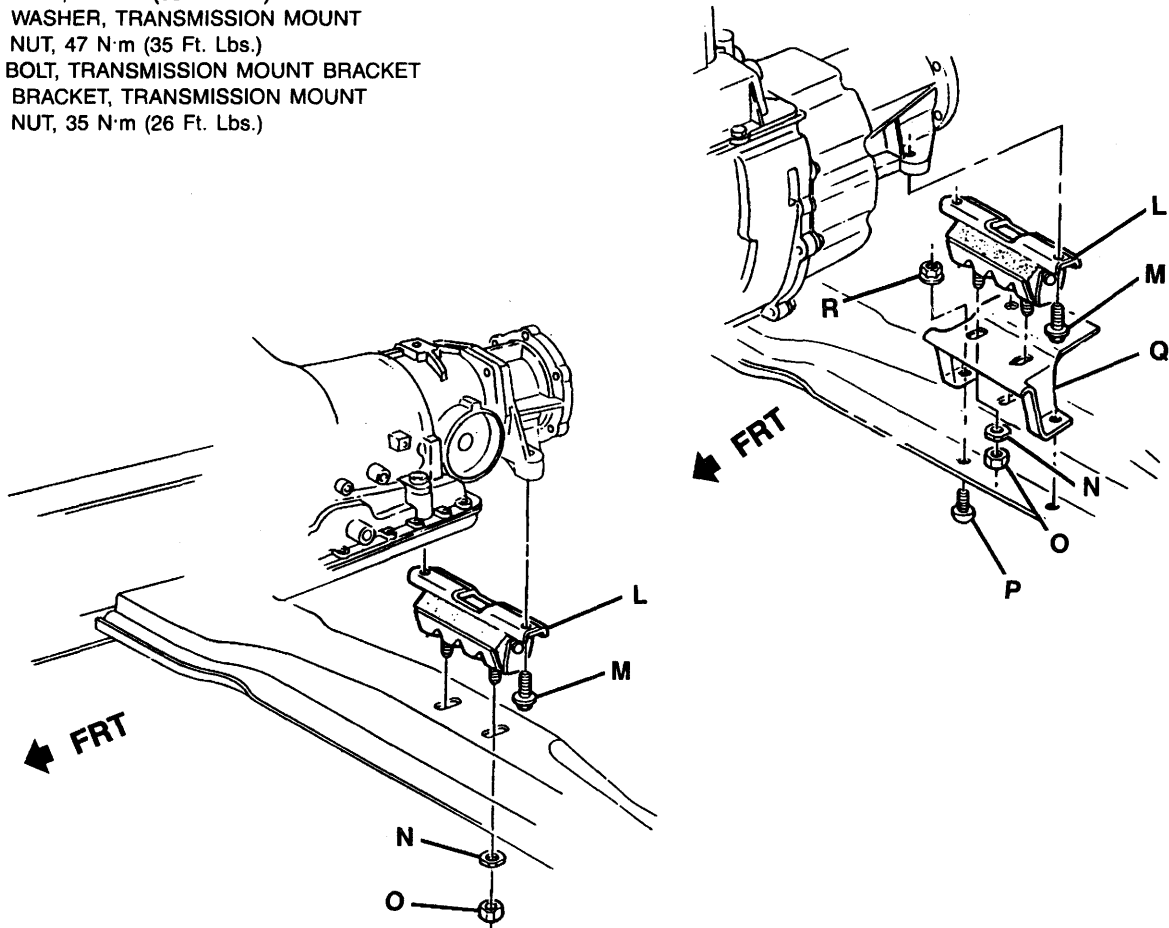


Figure 36—Rear Engine Mounting (C-Models)

- L. MOUNT, TRANSMISSION
M. BOLT, 47 N·m (35 Ft. Lbs.)
N. WASHER, TRANSMISSION MOUNT
O. NUT, 47 N·m (35 Ft. Lbs.)
P. BOLT, TRANSMISSION MOUNT BRACKET
Q. BRACKET, TRANSMISSION MOUNT
R. NUT, 35 N·m (26 Ft. Lbs.)



V2762

Figure 37—Rear Engine Mounting (2WD with 15,000 GVW and 4WD Models)

5. Necessary engine wiring:

- Starter and solenoid wires.
- Generator wires.
- Temperature sensor wire.
- Oil pressure sender wire.
- Distributor or coil wires.
- Any other necessary wiring.

6. Accelerator and cruise control linkages (if equipped).

7. Fuel supply lines.

8. Necessary vacuum hoses:

- Evaporative emission hoses.
- Vacuum booster hose (if used).
- Cruise control hose (if used).
- Any other necessary vacuum hoses.

9. Power steering pump, and lay aside.

10. Air conditioning compressor, and lay aside.

- Raise the vehicle. Support with safety stands.

11. Exhaust pipes at the manifolds.

12. Starter motor.

13. Flywheel or torque converter cover.

14. Flex plate to torque converter bolts (automatic transmission).

- Lower the vehicle.
- Support the transmission.
- Attach a suitable lifting fixture.

15. Bell housing to engine bolts.

16. Front engine mounting through bolts.

17. Engine.

Install or Connect (Figures 33, 34, and 35)

1. Engine in the vehicle.

NOTICE: Refer to "Notice" on page 6A5-1.

2. Engine mounting through bolts and nuts.



Tighten

- Fasteners to specifications. Refer to figures 33, 34, and 35.

3. Bell housing bolts.
 - Remove the lifting fixture and transmission jack.
 - Raise the vehicle. Support with safety stands.
4. Flex plate to torque converter bolts (automatic transmission).
5. Flywheel or torque converter cover.
6. Starter motor.
7. Exhaust pipes at the manifolds.
8. Air conditioning compressor.
9. Power steering pump.
10. Vacuum hoses.
11. Fuel supply line.
12. Accelerator and cruise control linkages (if equipped).
13. Engine wiring.
14. Radiator and fan shroud: Refer to SECTION 6B2.
15. Air cleaner.
16. Hood.
17. Negative battery cable.
18. Proper quantity and grade of coolant. Refer to SECTION 0B.
 - Check for leaks.

THREAD REPAIR

Damaged threads may be reconditioned by drilling out, rethreading, and installing a suitable thread insert.

Tools Required:

General purpose thread repair kits are available commercially.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch, and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to required depth.

! Important

- Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.
2. Drill out damaged thread. Clean out chips.
 3. Tap hole. Lubricate tap with light engine oil. Clean the thread.

! Important

- Avoid buildup of chips. Back out the tap every few turns and remove chips.
4. Thread the thread insert onto the mandrel of the installer (figure 38). Engage the tang of the insert onto the end of the mandrel.
 5. Lubricate the insert with light engine oil (except when installing in aluminum) and install.

! Important

- When correctly installed, the insert should be flush to one turn below the surface.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

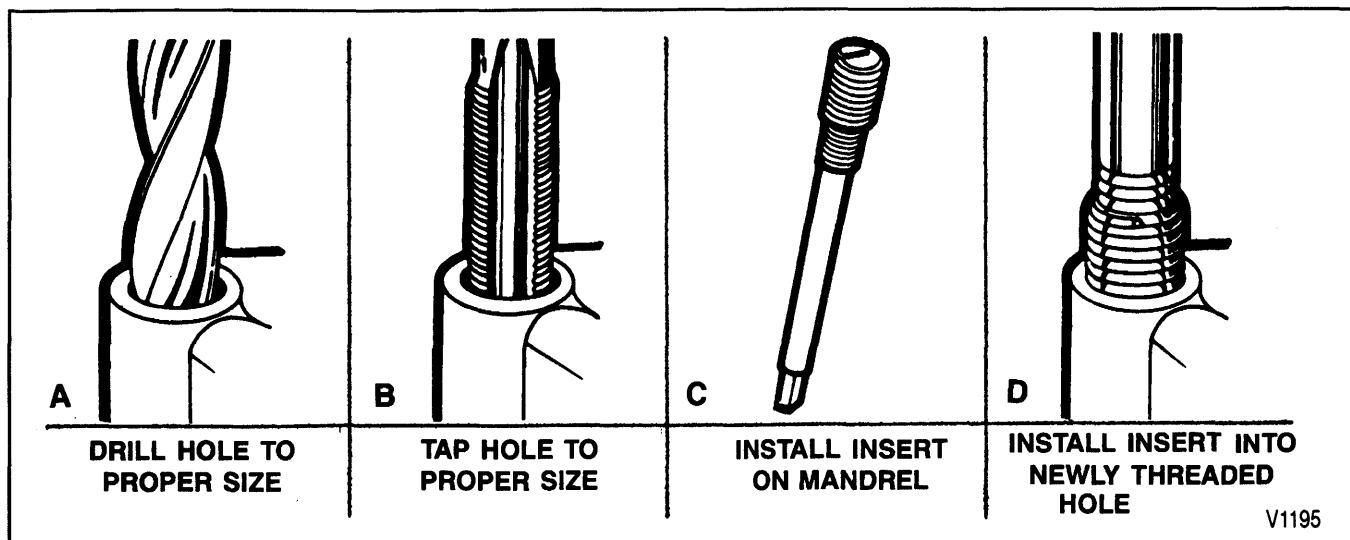


Figure 38—Repairing Thread Holes

SPECIFICATIONS

ENGINE SPECIFICATIONS (7.4L)

All Specifications are in INCHES unless otherwise noted.

GENERAL DATA:				
Type			V8	
Displacement			7.4L (454 CID)	
RPO			L19	
Bore			4.25	
Stroke			4.00	
Compression Ratio			7.9:1	
Firing Order			1-8-4-3-6-5-7-2	
Oil Pressure (Minimum)*			10 psi @ 600 RPM Minimum; 25 psi @ 2000 RPM	
CYLINDER BORE:				
Diameter			4.2500-4.2507	
Out Of Round	Production		0.001 (Maximum)	
	Service		0.002 (Maximum)	
Taper	Production	Thrust Side	0.0005 (Maximum)	
		Relief Side	0.001 (Maximum)	
	Service		0.001 (Maximum)	
PISTON:				
Clearance	Production		0.0018-0.0030	
	Service Limit		0.005 (Maximum)	
PISTON RING:				
C O M P R E S S I O N	Groove Clearance	Production	Top	0.0012-0.0029
			2nd	0.0012-0.0029
		Service Limit		Hi Limit Production +0.001
	Gap	Production	Top	0.010-0.018
			2nd	0.016-0.024
		Service Limit		Hi Limit Production + 0.010
O I L	Groove Clearance	Production		0.0050-0.0065
		Service Limit		Hi Limit Production + 0.001
	Gap	Production		0.010-0.030
		Service Limit		Hi Limit Production + 0.010
PISTON PIN:				
Diameter			0.98945-0.98965	
Clearance In Piston	Production		0.0002-0.0007	
	Service Limit		0.001 (Maximum)	
Fit In Rod			0.0031-0.0021 Interference	

*Measure on a "Warm Engine." Pressures will be higher on a cold engine.

SPECIFICATIONS

ENGINE SPECIFICATIONS (7.4 L) (CONT.)

All Specifications are in INCHES unless otherwise noted.

DISPLACEMENT:			7.4L
CRANKSHAFT:			
Main Journal	Diameter	#1, #2, #3, #4, #5	2.7482-2.7489
	Taper	Production	0.0004 (Maximum)
		Service Limit	0.001 (Maximum)
	Out Of Round	Production	0.0004 (Maximum)
		Service Limit	0.001 (Maximum)
Main Bearing Clearance	Production	#1, #2, #3, #4	0.0017-0.0030
		#5	0.0025-0.0038
	Service Limit	#1, #2, #3, #4	0.0010-0.0030
		#5	0.0025-0.0040
Crankshaft End Play			0.005-0.011
Crankpin	Diameter		2.1990-2.1996
	Taper	Production	0.0005
		Service Limit	0.001
	Out Of Round	Production	0.0005
		Service Limit	0.001
Rod Bearing Clearance	Production		0.0011-0.0029
	Service Limit		0.003 (Maximum)
Rod Side Clearance			0.0013-0.023
CAMSHAFT:			
Lobe Lift ± 0.002	Intake		0.2343
	Exhaust		0.2530
Journal Diameter			1.9482-1.9492
VALVE SYSTEM:			
Lifter			Hydraulic
Rocker Arm Ratio			1.70:1
Valve Lash		Intake	Net Lash
		Exhaust	
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			0.002 (Maximum)
Seat Width		Intake	1/32-1/16
		Exhaust	1/16-3/32
Stem Clearance	Production	Intake	0.0010-0.0027
		Exhaust	0.0012-0.0029
	Service	Intake	High Limit Production +0.001
		Exhaust	High Limit Production +0.002
Valve Spring	Free Length		2.12
	Pressure lbs. @ in.	Closed	74-86 lbs. @ 1.80-in.
		Open	195-215 lbs. @ 1.40-in.
	Installed Height ± 1/32"		1 51/64 (1.80 in.)
Valve Spring Fit In Damper			0.065-0.116 Interference

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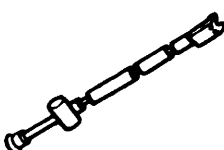
SPECIFICATIONS (CONT.)

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	Lbs. Ft.	Lbs. In.
Camshaft Sprocket Bolts	26	20	—
Connecting Rod Bolt Nuts	66	48	—
Coolant Outlet Bolts	40	30	—
Coolant Pump Bolts	40	30	—
Cylinder Head Bolts (In Sequence)	110	80	—
Engine Block Drain Plug	12	—	112
Exhaust Manifold Bolts	54	40	—
Flywheel Bolts	90	65	—
Flywheel Housing Bolts	40	30	—
Front Cover Bolts	10	—	96
Intake Manifold Bolts (In Sequence)	45	35	—
Main Bearing Cap Bolts	135	100	—
Oil Pan Bolts	18	13	—
Oil Pan Drain Plug	28	20	—
Oil Pump Bolt	90	65	—
Oil Pump Cover Bolts	9	—	80
Rocker Arm Bolts	54	40	—
Rocker Arm Cover Bolts	7	—	70
Spark Plugs	30	22	—
Torsional Damper Bolt	115	85	—

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SPECIAL TOOLS

- | | | | | | |
|----|---|----------|-----|---|-----------|
| 1. |  | J 39046 | 7. |  | J 5239 |
| 2. |  | J 5892-C | 8. |  | J 9290-01 |
| 3. |  | J 23590 | 9. |  | J 3049-A |
| 4. |  | J 22102 | 10. |  | J 28509-A |
| 5. |  | J 8080 | 11. |  | J 8520 |
| 6. |  | J 8037 | 12. |  | J 38841 |

1. TORSIONAL DAMPER REMOVER AND INSTALLER
2. VALVE SPRING COMPRESSOR
3. AIR ADAPTER
4. CRANKSHAFT SEAL INSTALLER AND CENTERING TOOL
5. MAIN BEARING REPLACER
6. PISTON RING COMPRESSOR
7. GUIDE SET
8. HYDRAULIC LIFTER REMOVER (SLIDE HAMMER TYPE)
9. HYDRAULIC LIFTER REMOVER (PLIER TYPE)
10. CRANKSHAFT SPROCKET PULLER
11. DIAL INDICATOR ADAPTER
12. CRANKSHAFT REAR SEAL INSTALLER

SECTION 6A6

6.5L DIESEL

RPO L49, VIN P

RPO L56, VIN S

RPO L65, VIN F

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The 6.5L diesel engine is a 90-degree V8 type, with indirect-type combustion chambers. There are three versions of the 6.5L engine used for C/K models. Two of the engines are turbocharged (L56, VIN S and L65, VIN F) and one is naturally aspirated (L49, VIN P).

The crankshaft is supported by five precision insert main bearings, with crankshaft thrust taken at the number three (center) main bearing.

The camshaft is supported by five plain-type bearings and is chain driven. Motion from the camshaft is transmitted to the overhead valves by roller type hydraulic lifters, pushrods, and spindle mounted rocker arms. The valve guides are integral in the cylinder head.

The connecting rods are forged steel with precision insert type crankshaft bearings. The piston pins are retained by snap rings.

For a disassembled view of the 6.5L engine, refer to figures 1 through 4.

For bench repair of the 6.5L diesel engine, refer to the Light Duty Truck Unit Repair Manual.

For information about the turbocharger, refer to SECTION 6J.

ENGINE LUBRICATION

A lubrication schematic is shown in figure 5.

The gear-type oil pump is driven from the drive gear. The drive gear is driven by the camshaft. Oil is drawn into the pump through a pickup screen and pipe.

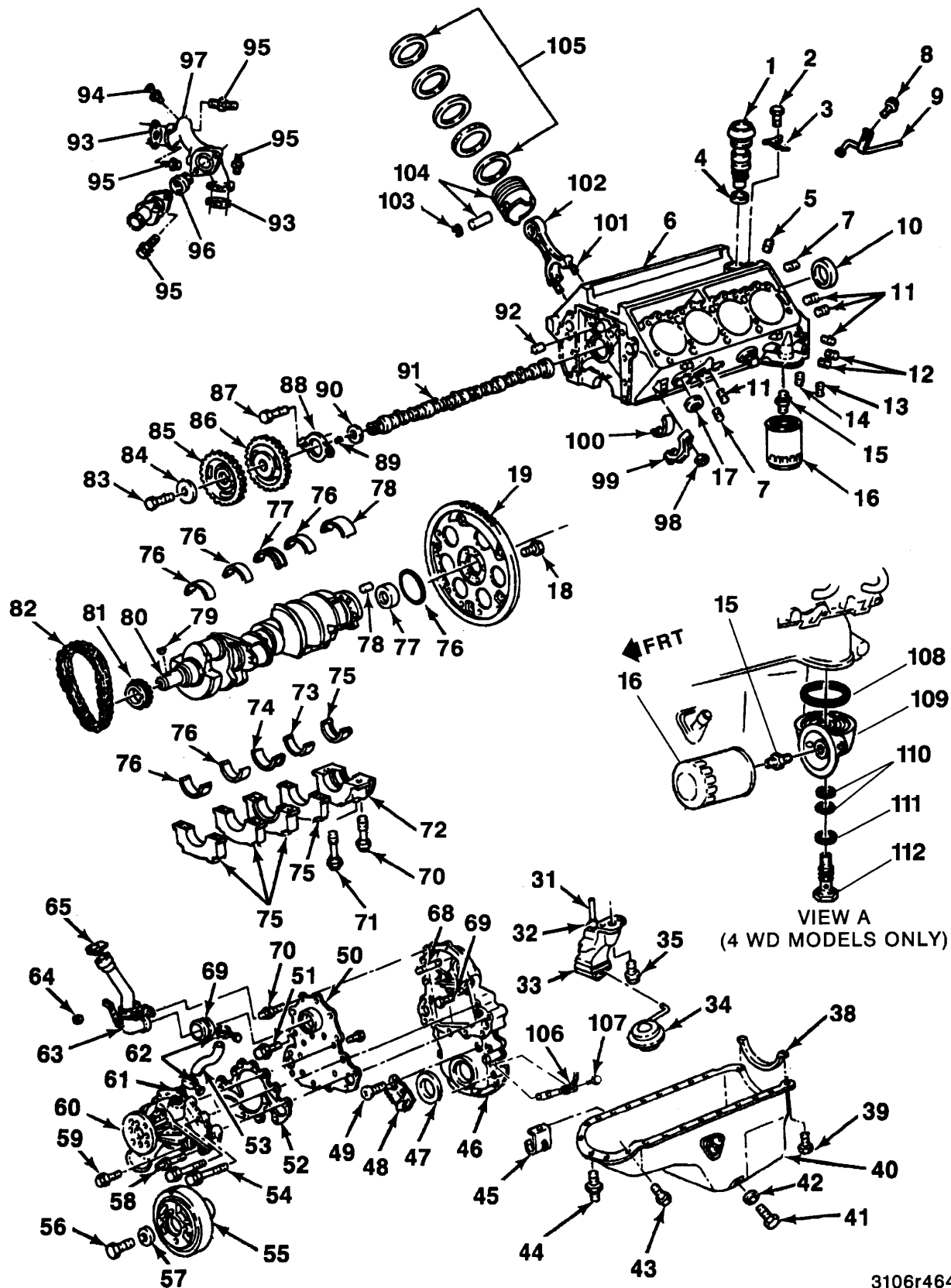
Pressurized oil is routed to the oil cooler in the radiator. A bypass valve is provided should the oil cooler become restricted. Oil flows from the cooler to a full flow oil filter. An oil filter bypass valve is provided should the oil filter become restricted.

Oil flows from the oil filter to the oil galleries, providing pressurized lubrication to various components.

The hydraulic valve lifters receive oil from the oil galleries. Oil flows from the hydraulic lifters through hollow pushrods to the rocker arms. Oil from overhead drains back to the crankcase through oil drain holes.

The pistons, piston rings, cylinder walls, and connecting rod small end bearings are lubricated by oil splash.

The turbocharger is supplied oil from the right side lifter gallery through a braided steel line to the top of the center housing. The oil returns to the crankcase by a drain tube that goes from the turbocharger center housing to the lower right hand side of the engine block.



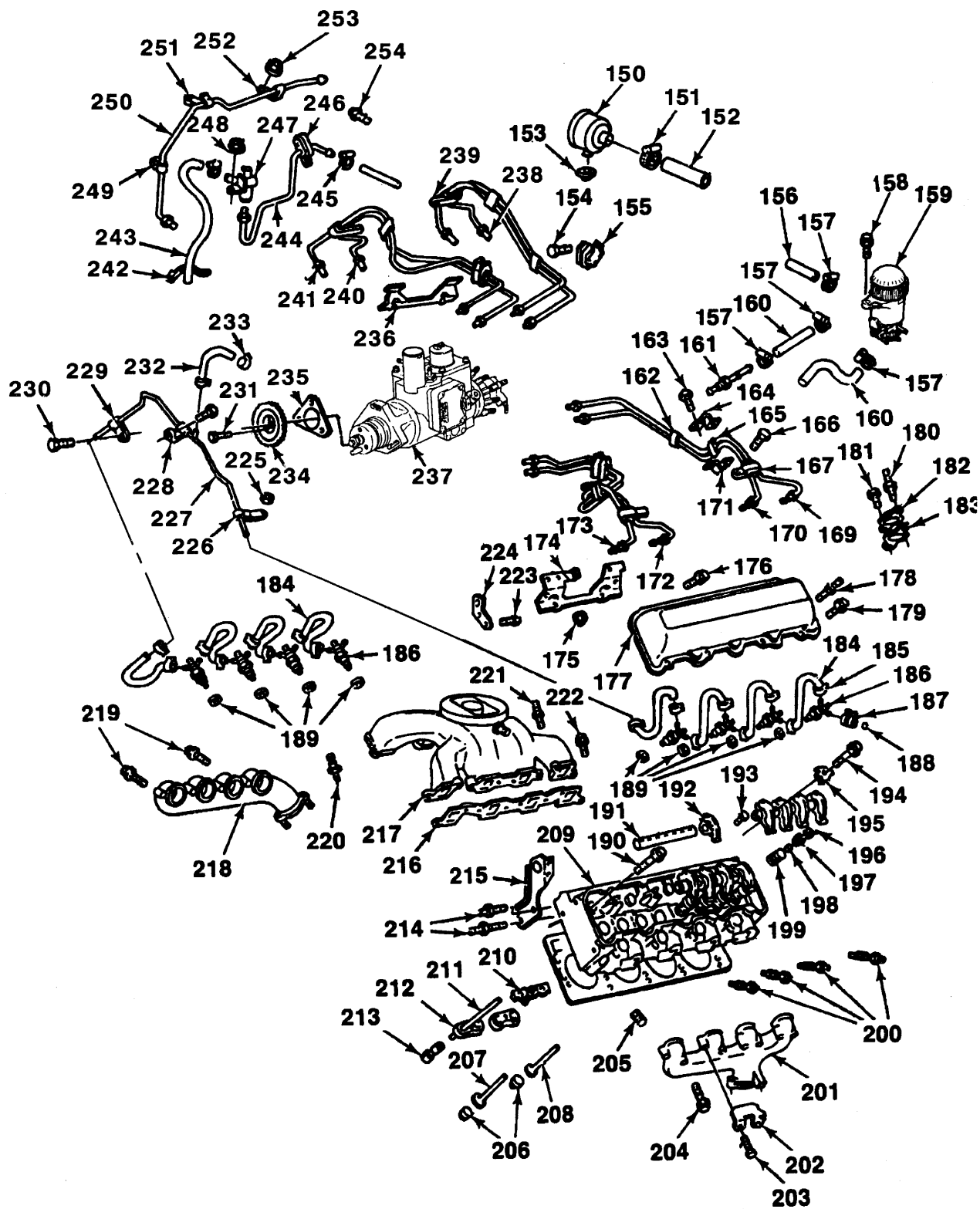
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Figure 1—Cylinder Block and Components

- | | | |
|--------------------------------|--|--|
| 1. Oil Pump Drive | 51. Bolt | 84. Camshaft Washer |
| 2. Bolt | 52. Coolant Plate Gasket | 85. Fuel Injection Drive Gear |
| 3. Oil Pump Drive Clamp | 53. Thermostat By-Pass Hose | 86. Camshaft Sprocket |
| 4. Oil Pump Drive Gasket | 54. Coolant Pump and Plate Bolt | 87. Camshaft Bolt |
| 5. Oil Pressure Sensor Plug | 55. Torsional Damper | 88. Camshaft Thrust Bearing |
| 6. Block | 56. Torsional Damper Bolt | 89. Camshaft Sprocket Key |
| 7. Plug | 57. Torsional Damper Bolt Washer | 90. Camshaft Sprocket Spacer Ring |
| 8. Bolt | 58. Coolant Pump Stud | 91. Camshaft |
| 9. Fuel Drain Tube | 59. Coolant Pump Bolt | 92. Oil Galley Hole Plug |
| 10. Rear Camshaft Bearing Plug | 60. Coolant Pump | 93. Coolant Crossover Gasket |
| 11. Plug | 61. Thermostat By-Pass Nipple | 94. Glow Plug Inhibit Switch |
| 12. Oil Cooler Line Plug | 62. Clamp | 95. Coolant Crossover Stud |
| 13. Oil Cooler Plug | 63. Oil Fill Tube | 96. Thermostat |
| 14. Main Galley Hole Plug | 64. Nut | 97. Coolant Crossover and Thermostat Housing |
| 15. Oil Filter Connector | 65. Oil Filler Cap | 98. Connecting Rod Nut |
| 16. Oil Filter (PF35) | 66. Oil Separator Grommet | 99. Connecting Rod Bearing Cap |
| 17. Coolant Jacket Plug | 67. Coolant Pump and Plate Stud | 100. Connecting Rod Bearing |
| 18. Flywheel Bolt | 68. Fuel Injection Pump Stud | 101. Connecting Rod Bolt |
| 19. Flywheel | 69. Bolt | 102. Connecting Rod |
| 31. Oil Pump Shaft | 70. Crankshaft Bearing Cap Bolt (Outboard) | 103. Piston Pin Retainer |
| 32. Retainer | 71. Crankshaft Bearing Cap Bolt (Inboard) | 104. Piston and Pin |
| 33. Oil Pump | 72. Crankshaft Bearing Cap | 105. Rings |
| 34. Oil Pump Screen | 73. Crankshaft Bearings | 106. Crankshaft Sensor |
| 35. Oil Pump and Screen Bolt | 74. Crankshaft Bearing (Thrust) | 107. Bolt |
| 36. Clutch Housing (W/JF9) | 75. Crankshaft Bearing (Rear) | 108. Oil Filter Adapter Seal |
| 37. Clutch Housing Bolt | 76. Crankshaft Rear Oil Seal (One Piece) | 109. Oil Filter Adapter |
| 38. Rear Oil Pan Seal | 77. Clutch Pilot Bearing | 110. Oil Filter Adapter O - Ring Seals |
| 39. Bolt | 78. Flywheel Dowel Pin | 111. Oil Filter Adapter Gasket |
| 40. Oil Pan | 79. Crankshaft Sprocket Key | 112. Oil Filter Adapter Bolt |
| 41. Oil Pan Drain Plug | 80. Crankshaft | 63 N·m (47 Lbs. Ft.) |
| 42. Oil Pan Drain Plug Gasket | 81. Crankshaft Sprocket | |
| 43. Oil Pan Bolt | 82. Camshaft Timing Chain | |
| 44. Oil Pan Stud | 83. Camshaft Bolt | |
| 45. Oil Cooler Pipe Stud | | |
| 46. Front Crankcase Cover | | |
| 47. Crankcase Front Oil Seal | | |
| 48. Timing Pointer | | |
| 49. Timing Pointer Screw | | |
| 50. Coolant Pump Backing Plate | | |

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Figure 2—Cylinder Block and Components - Legend



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Figure 3—Cylinder Head, Manifolds, and Components

- | | | |
|---|---|-------------------------------|
| 150. Crankcase Depression Regulator Valve (CDR) | 196. Valve Stem Key | 240. Fuel Injection Pipe (#4) |
| 151. Clamp | 197. Exhaust Valve Rotator | 241. Fuel Injection Pipe (#2) |
| 152. Hose (CDR) | 198. Exhaust Valve Seal | 242. Plastic Retainer |
| 153. Grommet (CDR) | 199. Valve Spring | 243. Fuel Evaporation Hose |
| 154. Fuel Injection Clamp Bolt | 200. Glow Plugs | 244. Water Drain Hose |
| 155. Fuel Injection Pipe Clamp | 201. Exhaust Manifold L.H. | 245. Clamp |
| 156. Fuel Filter Inlet Hose | 202. Dipstick Tube Shield | 246. Water Drain Pipe Insert |
| 157. Clamp | 203. Exhaust Manifold Bolt | 247. Water Drain Valve |
| 158. Fuel Filter Bolt | 204. Exhaust Manifold Bolt | 248. Nut |
| 159. Fuel Filter Assembly | 205. Coolant Temperature Switch Hole Plug | 249. Fuel Inlet Pipe Clip |
| 160. Fuel Filter Outlet Hose | 206. Prechamber | 250. Fuel Filter Inlet Tubing |
| 161. Fuel Filter Outlet Tubing | 207. Intake Valve | 251. Fuel Pipe Clip |
| 162. Fuel Injection Pipe Insert | 208. Exhaust Valve | 252. Fuel Pipe Clip |
| 163. Bolt | 209. Cylinder Head | 253. Nut |
| 164. Fuel Injection Pipe Clip | 210. Hydraulic Valve Lifter Guide Clamp (Upper) | 254. Bolt |
| 165. Fuel Injection Pipe Insert | 211. Push Rod | |
| 166. Bolt | 212. Hydraulic Valve Lifter Guide Plate (Upper) | |
| 167. Fuel Injection Pipe Clip | 213. Valve Lifter | |
| 169. Fuel Injection Pipe (#7) | 214. Engine Lifting Studs | |
| 170. Fuel Injection Pipe (#5) | 215. Front Engine Lifting Bracket | |
| 171. Fuel Injection Pipe Clip | 216. Intake Manifold Gasket | |
| 172. Fuel Injection Pipe (#3) | 217. Intake Manifold | |
| 173. Fuel Injection Pipe (#1) | 218. Exhaust Manifold R.H. | |
| 174. Fuel Injection Pipe L.H. Bracket | 219. Exhaust Manifold Bolts | |
| 175. Nut | 220. Cold Advance Temperature Switch | |
| 176. Rocker Cover Bolt | 221. Intake Manifold Stud | |
| 177. Rocker Arm Cover L.H. | 222. Intake Manifold Bolt | |
| 178. Rocker Arm Cover Stud | 223. Rear Engine Lift Bracket Bolt | |
| 179. Rocker Arm Cover Bolt | 224. Rear Engine Lift Bracket | |
| 180. Coolant Crossover Stud | 225. Fuel Drain Back Pipe Clip Nut | |
| 181. Cylinder Head Coolant Jacket Cover Bolt | 226. Fuel Drain Back Pipe Clip | |
| 182. Cylinder Head Coolant Jacket Cover | 227. Fuel Drain Back Pipe | |
| 183. Cylinder Head Coolant Jacket Gasket | 228. Fuel Drain Back Pipe Clip | |
| 184. Fuel Drain Back Hose | 229. Fuel Drain Back Pipe Clip | |
| 185. Clamp | 230. Bolt | |
| 186. Injection Nozzle | 231. Fuel Injection Pump Driven Gear | |
| 187. Clamp | 232. Fuel Drain Back Hose | |
| 188. Fuel Injector Nozzle Cap | 233. Clamp | |
| 189. Injection Nozzle Gaskets | 234. Fuel Injection Pump Driven Gear | |
| 190. Cylinder Head Bolt | 235. Fuel Injection Pump Gasket | |
| 191. Rocker Arm Shaft | 236. Fuel Injection Pipe Bracket L.H. | |
| 192. Rocker Arm | 237. Fuel Injection Pump | |
| 193. Rocker Arm Retainer | 238. Fuel Injection Pipe (#8) | |
| 194. Rocker Arm Shaft Bolt | 239. Fuel Injection Pipe (#6) | |
| 195. Rocker Arm Shaft Retainer | | |

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Figure 4—Cylinder Head, Manifolds, and Components - Legend

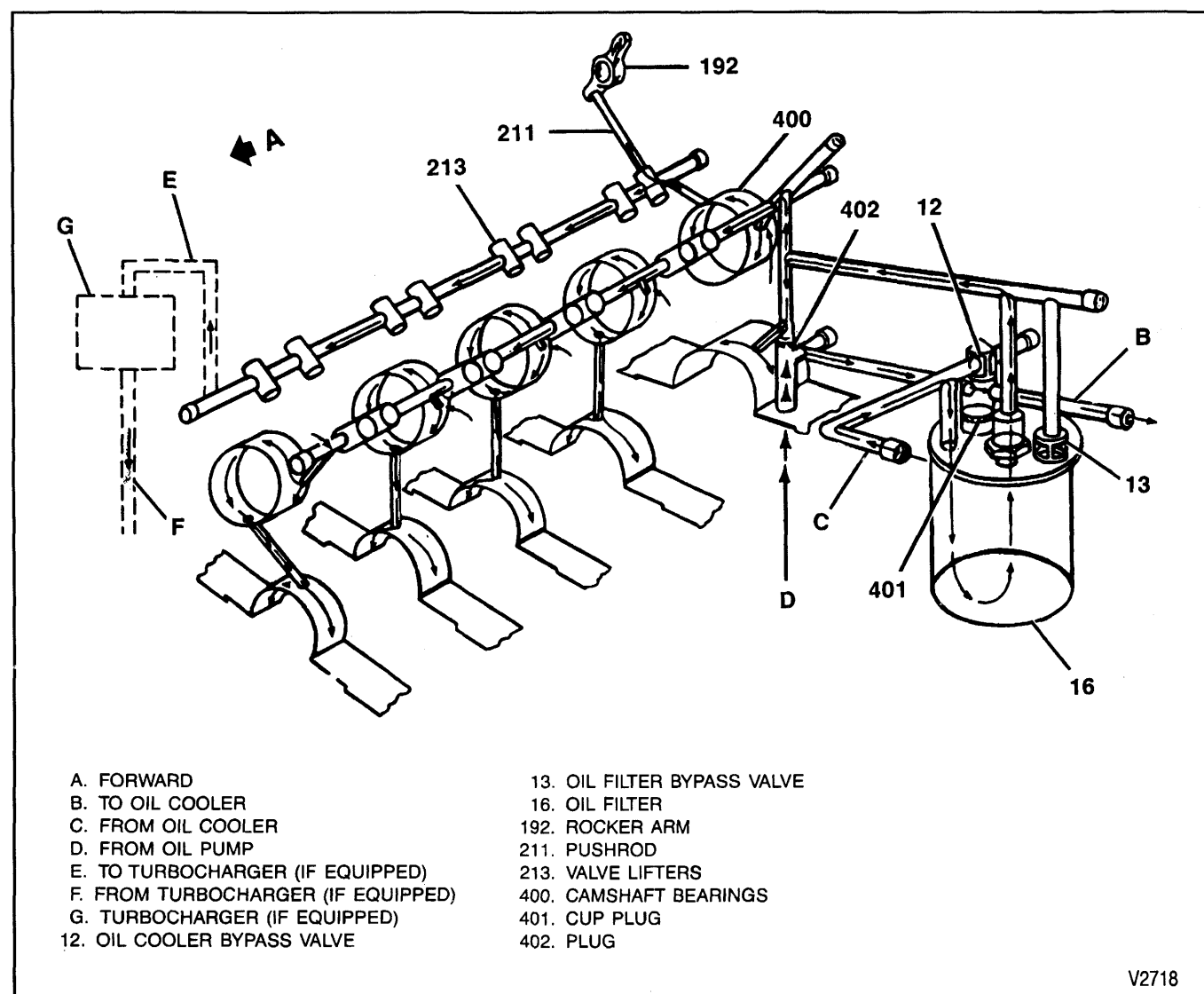


Figure 5—Lubrication Diagram

DIAGNOSIS OF DUAL MASS FLYWHEEL

PROBLEM	POSSIBLE CAUSE	CORRECTION
Clutch Noisy	Dual mass flywheel springs or spring retainers broken.	Replace dual mass flywheel.
Clutch Slips After the Pedal is Fully Released	Dual mass flywheel internal components worn, loose or saturated with oil.	Replace dual mass flywheel.
Clutch Does Not Disengage Completely	Dual mass flywheel bent or broken.	Replace dual mass flywheel.
Clutch Vibrates	1. Dual mass flywheel attaching bolts loose. 2. Dual mass flywheel central bearing worn or broken.	1. Re-tighten bolts. 2. Replace dual mass flywheel.
Transmission Rattles when Clutch Engaged with Transmission in Neutral and Engine at Idle	1. Transmission internal damage. 2. Dual mass flywheel central bearing worn or broken.	1. Refer to SECTION 7. 2. Replace dual mass flywheel.
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ON-VEHICLE SERVICE

INTAKE MANIFOLD REPLACEMENT



Remove or Disconnect (Figure 6)

Tool Required:

J 29664 Manifold Cover Set

1. Negative battery cables. Refer to SECTION 0A.
2. Air cleaner.
3. Fuel filter. Refer to SECTION 6C.
4. Generator rear bracket.
5. EGR/EPR solenoids with bracket from the intake manifold studs.
6. CDR hose at the manifold.
7. EGR and crankcase ventilation hoses.
8. Fuel line bracket and ground strap.
9. Intake manifold bolts and fuel line clips.
10. Intake manifold and gasket.



Important

- If any further service work is to be done, cover the intake ports with J 29664-1.



Clean

- Gasket surfaces on intake manifold and cylinder heads.



Install or Connect (Figure 6)

1. New gaskets.



Important

- Be sure to use the correct gasket. The gaskets for light duty emissions models have openings for the EGR ports. The gaskets for heavy duty emissions models do not.
2. Intake manifold.

NOTICE: Refer to "Notice" on page 6A6-1.

3. Intake manifold bolts and fuel line clips.



Tighten

- Intake manifold bolts to 42 N.m (32 lbs. ft.). Use the tightening sequence shown in figure 6.
4. Fuel line bracket and ground strap.
 5. EGR and crankcase ventilation hoses.
 6. CDR hose.
 7. EGR/EPR solenoids with bracket.
 8. Generator rear bracket.
 9. Fuel filter. Refer to SECTION 6C.
 10. Air cleaner.
 11. Negative battery cable(s). Refer to SECTION 0A.

EXHAUST MANIFOLD REPLACEMENT

LEFT SIDE MANIFOLD



Remove or Disconnect (Figure 7)

1. Negative battery cable(s). Refer to SECTION 0A.
- Raise the vehicle and support with safety stands.

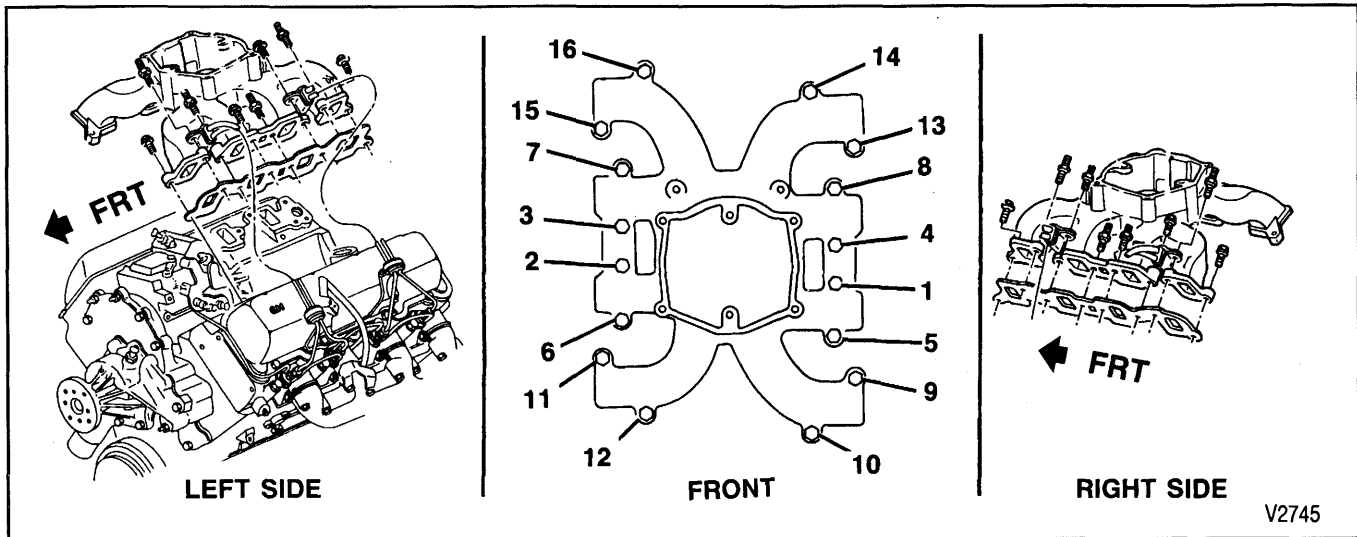


Figure 6—Intake Manifold

2. EPR valve.
3. Engine oil cooler line clip and bracket.
4. Exhaust pipe from the manifold.
5. Exhaust manifold bolts.
6. Exhaust manifold from under the vehicle.



Clean

- Sealing surfaces on exhaust manifold and cylinder head.
- Threads on manifold bolts.



Install or Connect (Figure 7)

1. Exhaust manifold from under the vehicle.

NOTICE: Refer to "Notice" on page 6A6-1.

2. Exhaust manifold bolts.



Tighten

- Bolts to 35 N·m (26 lbs. ft.).
3. Exhaust pipe to the manifold.
 - Lower the vehicle.
 4. Engine oil cooler line and bracket.
 5. EPR valve.
 6. Negative battery cable(s).

RIGHT SIDE MANIFOLD



Remove or Disconnect (Figures 8 or 9)

1. Negative battery cables. Refer to SECTION 0A.
 - Raise the vehicle and support with safety stands.
2. Exhaust pipe from the manifold.
 - Lower the vehicle.
3. Turbocharger assembly (if used). Refer to SECTION 6J.
4. Exhaust manifold bolts.
5. Exhaust manifold.



Clean

- Sealing surfaces on the exhaust manifold and cylinder head.
- Threads on the exhaust manifold bolts.



Install or Connect (Figures 8 or 9)

NOTICE: Refer to "Notice" on page 6A6-1.

1. Exhaust manifold and bolts.



Tighten

- Bolts to 35 N·m (26 lbs. ft.)
2. Turbocharger assembly if equipped. Refer to SECTION 6J.
 - Raise the vehicle and support with safety stands.
 3. Exhaust pipe to the manifold.
 - Lower the vehicle.
 4. Negative battery cables.

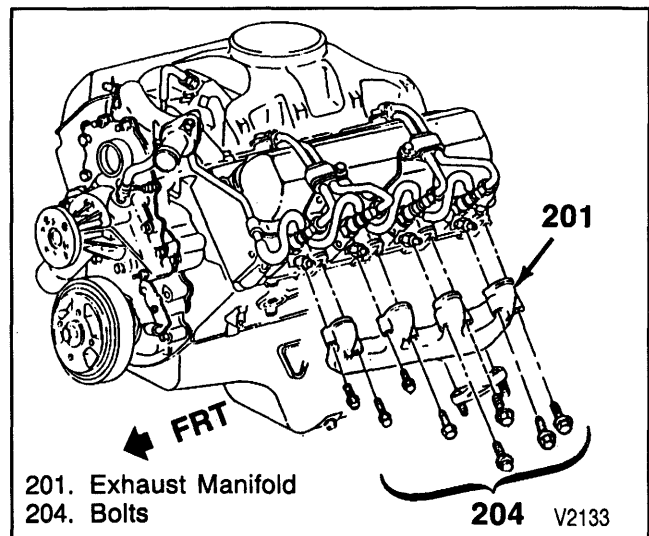


Figure 7—Exhaust Manifold (Left Side)

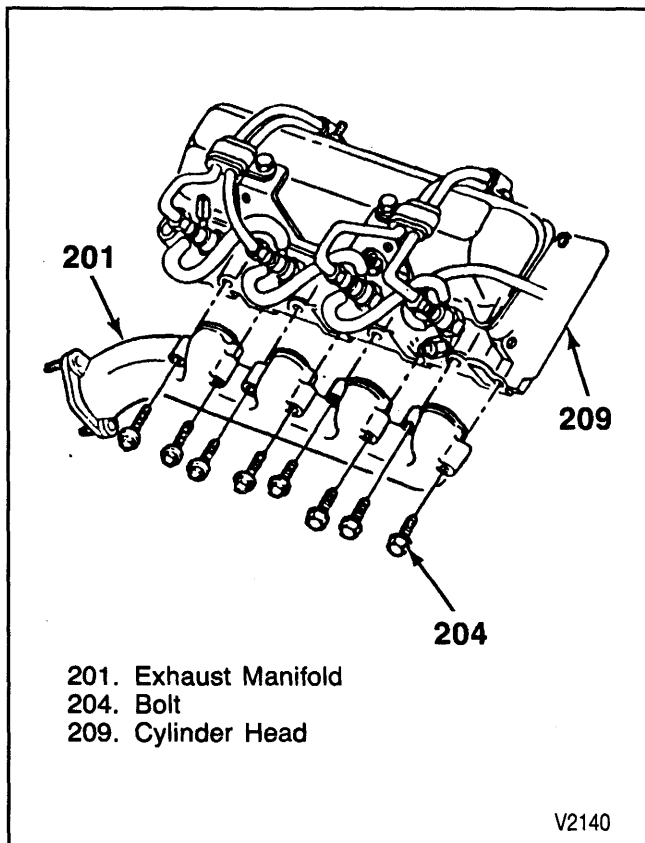


Figure 8—Exhaust Manifold (Right Side)

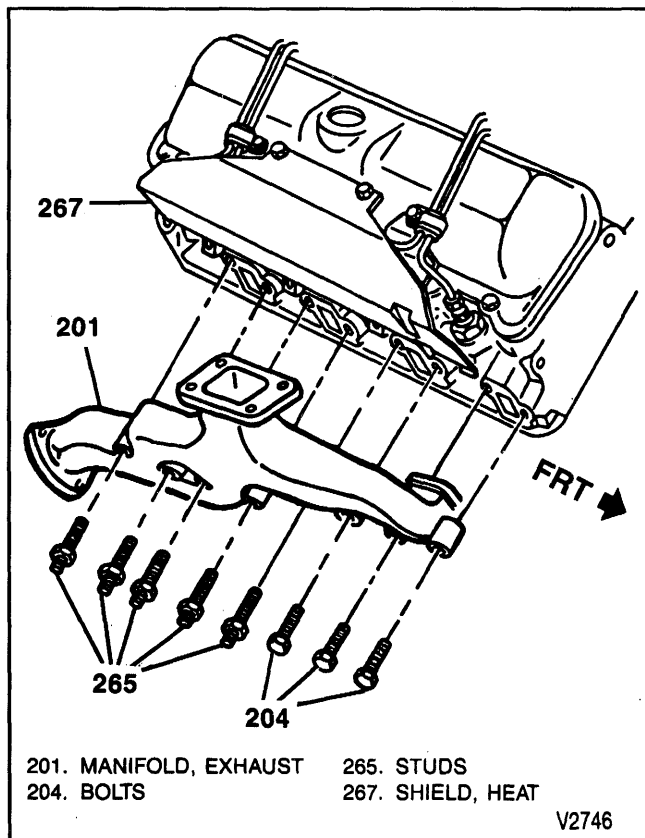


Figure 9—Exhaust Manifold (Right Side)

ROCKER ARM COVER REPLACEMENT



Remove or Disconnect

1. Intake manifold. Refer to "Intake Manifold Replacement."
2. Fuel injection lines. Refer to SECTION 6C2. (Injection lines for #5 and #7 cylinders do not have to be removed for right side rocker arm cover replacement).
3. CDR valve (right side cover).
4. Dipstick tube (left side cover).
5. Fuel return line clip at the cover stud.
6. Wiring harness at the rear of the cover from the clips and move aside.
7. Rocker arm cover bolts.

NOTICE: Do not pry on the rocker arm cover. Damage to sealing surfaces may result.

8. Rocker arm cover.



Clean

- RTV from the rocker arm cover and cylinder head. All loose RTV or pieces that will cause installation interference must be removed.
- Oil and grease from the sealing surfaces on the rocker arm cover and cylinder head. Use a suitable solvent.



Inspect

- Rocker arm cover sealing flanges for distortion. Replace as necessary.



Install or Connect (Figure 10)

NOTICE: Do not allow RTV sealant to enter the rocker arm cover bolt holes. This may cause a "hydraulic lock" condition when the bolts are tightened, damaging the cylinder head casting.

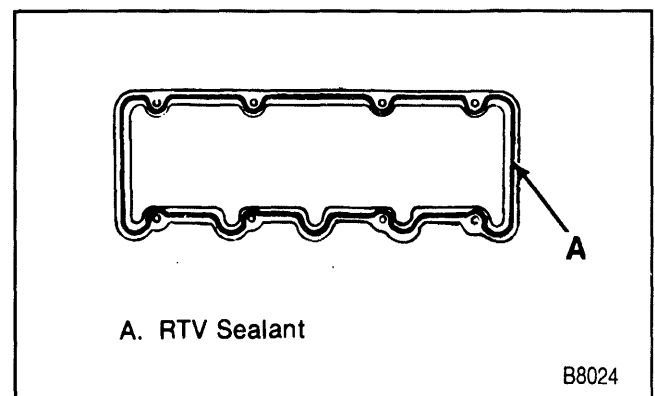


Figure 10—Applying Sealant to the Rocker Arm Cover

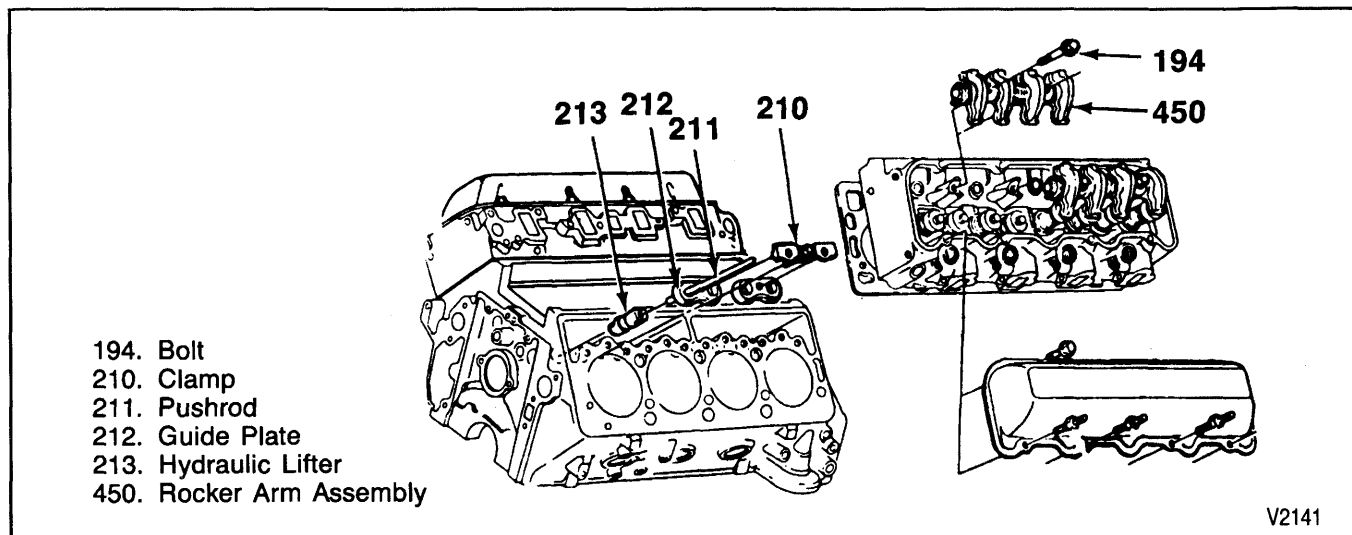


Figure 11—Valve Train Components

- Apply a 5-mm (3/16-inch) bead of RTV sealant (GM P/N 1052915) or equivalent to the rocker arm cover, inboard of the bolt holes. Refer to figure 10. The sealer must be wet to the touch when the bolts are torqued.

1. Rocker arm cover.

NOTICE: Refer to "Notice" on page 6A6-1.

2. Rocker arm cover bolts.



Tighten

- Bolts to 22 N.m (16 lbs. ft.).

3. Wiring harness.
4. Fuel return clips.
5. Dipstick tube (left side cover).
6. CDR valve (right side cover).
7. Fuel injection lines. Refer to SECTION 6C2.
8. Intake manifold. Refer to "Intake Manifold Replacement."

ROCKER ARM SHAFT, ROCKER ARMS, AND PUSHROD REPLACEMENT

Remove or Disconnect (Figures 11 and 12)

1. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."
2. Rocker arm shaft nuts.
3. Rocker arm shaft with rocker arms. Mark the assemblies so they can be returned to the original location at assembly.
4. Pushrods.



Important

- The pushrods must be installed in the original direction at assembly. This is because the pushrods have a different degree of hardness at each end. A paint stripe identifies the upper end

of the pushrod. If the paint stripe is not visible, mark the pushrods on the upper end as they are removed.

- The pushrods should be installed in the same location at assembly.

5. Rocker arms, if required.

- A. Insert a screwdriver into the rocker arm shaft bore and break off the end of the nylon rocker arm retainers.
- B. Remove the rocker arm retainers with pliers (figure 12).
- C. Slide the rocker arms from the shaft.



Install or Connect (Figures 11, 12, and 13)

1. Rocker arms to the rocker arm shaft. One type of rocker arm is used at all locations.



Important

- Lubricate the rocker arms with engine oil before installing.
2. Rocker arm retainers.
 - Center the rocker arms on the corresponding holes in the rocker arm shaft.
 - Install new retainers. Use a drift at least 13 mm (1/2 inch) in diameter.

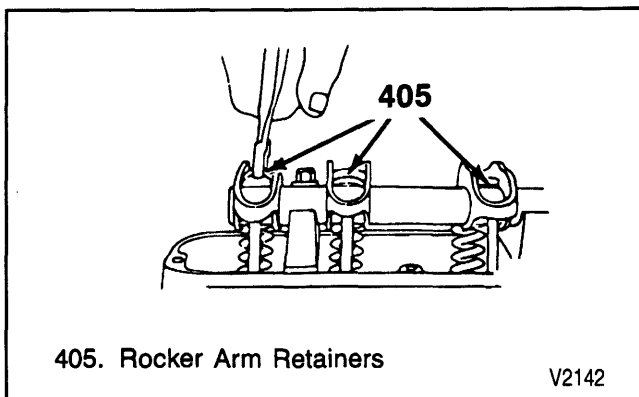


Figure 12—Removing the Rockers Arm Retainers

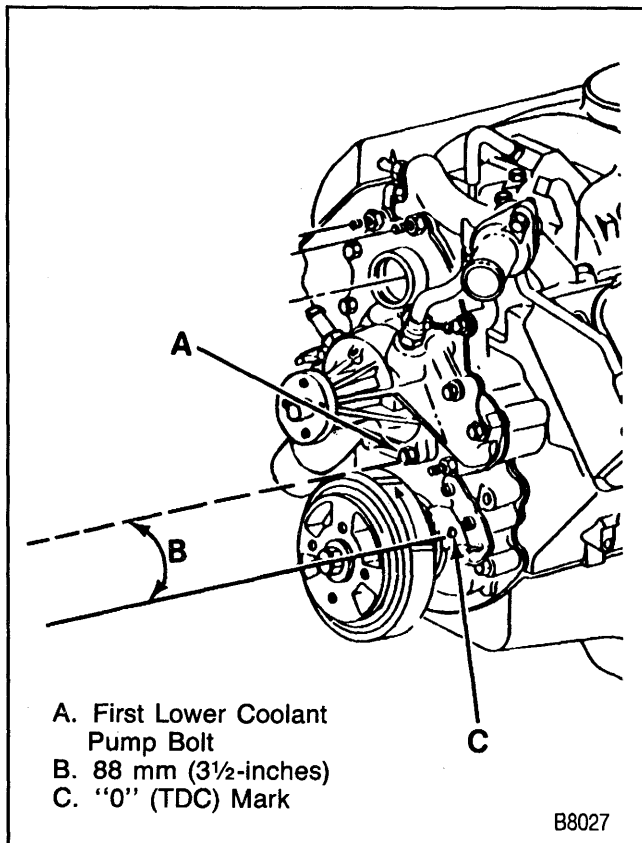


Figure 13—Aligning the Timing Mark

NOTICE: The pushrods must be installed with the marked or painted end up. Failure to do so may result in damage or premature wear.

3. Pushrods, with the painted or marked end up.
4. Rocker arm shaft assembly. Make sure the ball ends of the pushrods seat in the rocker arms.

NOTICE: Improper installation of the rocker arm shaft bolts may cause rocker arm shaft breakage and/or piston to valve contact.

NOTICE: Refer to "Notice" on page 6A6-1.

5. Rocker arm shaft bolts.
 - A. Rotate the engine until the mark on the torsional damper aligns with the "0" mark on the timing tab.
 - B. Rotate the engine to the left 88 mm (3 1/2 inch), measured at the torsional damper. This measurement can be estimated by aligning the torsional damper mark with the first lower coolant pump bolt (figure 13). This procedure will position the engine so no valves are close to a piston crown.
 - C. Install both bolts snug on the shaft.



Tighten

- Bolts alternately to 55 N.m (40 lbs. ft.).

6. Rocker arm cover. Refer to "Rocker Arm Cover Replacement."

HYDRAULIC LIFTER REPLACEMENT



Remove or Disconnect (Figures 11 and 14)

Tool Required:

J 29834 Hydraulic Lifter Remover

1. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
2. Rocker arm shaft with rocker arms and pushrods. Refer to "Rocker Arm Shaft, Rocker Arm, and Pushrod Replacement."



Important

- Rocker arm assemblies and pushrods must be marked for proper assembly.

3. Clamps.
4. Guide plates. Use mechanical fingers, if necessary.
5. Hydraulic lifters, through the access hole in the cylinder head. Use J 29834 (figure 14) and a magnet. Place the lifters in an organizer rack. The lifters must be installed in the same bores from which they were removed.



Inspect

- Hydraulic lifter body for scuffing and scoring. Replace the lifter if present.
- Roller for looseness and excessive play. Check for missing or broken needle bearings. Replace if necessary.
- Roller surface for pits and roughness. If present, the mating camshaft lobe should also be checked. If the lobe is pitted or rough, replace the camshaft and lifter.

HYDRAULIC LIFTER REPAIR

- Refer to SECTION 6A7 in the Light Duty Truck Unit Repair Manual.

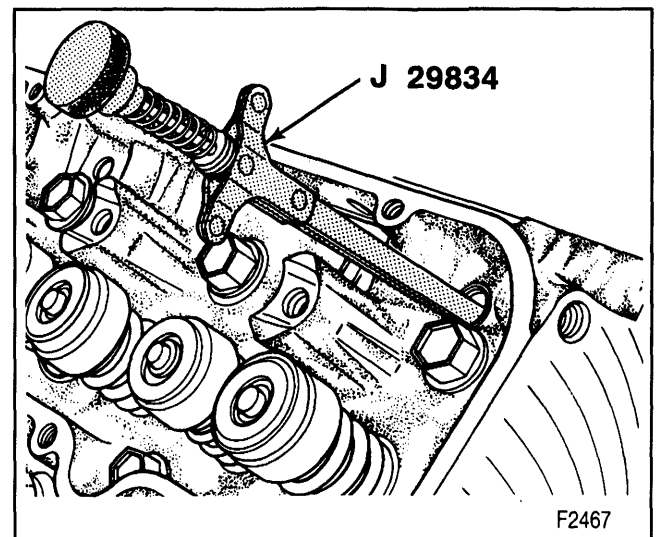


Figure 14—Removing the Hydraulic Lifter

! Important

- Some engines will have both standard and 0.010 inch oversize hydraulic lifters. The oversize lifter will have a "10" etched on the side. The block will be stamped "O.S." on the cast pad adjacent to the lifter bore and on the top rail of the cylinder case above the lifter bore.

↔ Install or Connect (Figure 11)

NOTICE: New hydraulic lifters must be primed before installation. Damage to the lifters may result if dry when the engine is started.

- Hydraulic lifters to the engine. Fabricate an installation tool from mechanic's wire.

! Important

- Prime new hydraulic lifters before installation by working the lifter plunger while submerged in clean kerosene or diesel fuel.
 - Coat the lifter roller and bearings with lubricant (GM P/N 1052365) or equivalent.
 - Lifters **MUST** be installed in their original locations.
- Guide plates.

NOTICE: Refer to "Notice" on page 6A6-1.

- Clamps.

⌘ Tighten

- Clamp bolt to 26 N.m (18 lbs. ft.).

! Important

- After all clamps are installed, turn the crankshaft by hand 720 degrees (two full turns), to ensure free movement of the lifters in the guide plates. If the engine will not turn over by hand, one or more of the lifters may be binding in the guide plate.
- Rocker arm shaft with rocker arms and pushrods in their original locations. Refer to "Rocker Arm Shaft, Rocker Arm, and Pushrod Replacement." Hardened ends of the pushrods must face up.
 - Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

VALVE STEM SEAL AND VALVE SPRING REPLACEMENT

↔ Remove or Disconnect (Figures 15 and 16)

Tools Required:

J 26999-10 Air Line Adapter

J 26999-30 Air Line Adapter (K models with quad front shocks)

J 38606 Valve Spring Compressor

- Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

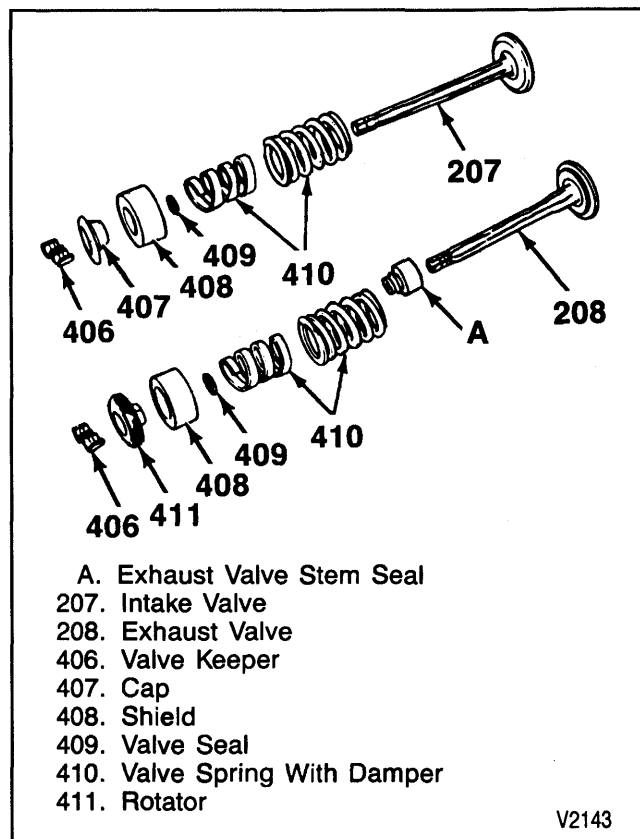


Figure 15—Valves and Components

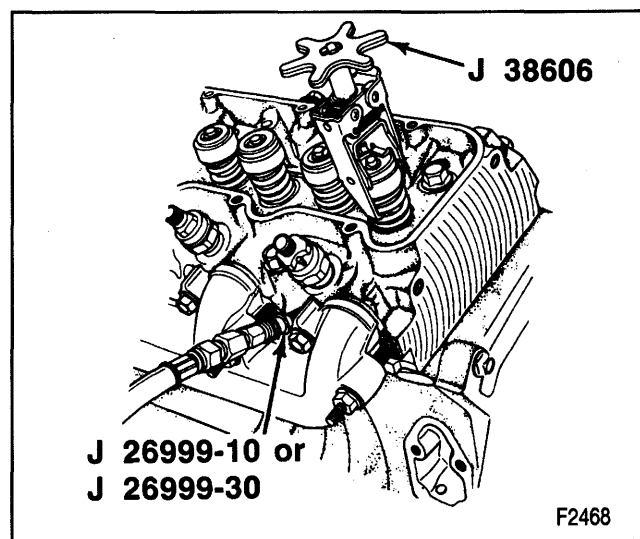


Figure 16—Compressing the Valve Spring

- Rocker arm shaft with rocker arms. Refer to "Rocker Arm Shaft, Rocker Arms, and Pushrod Replacement." Mark the assemblies so they can be returned to their original locations.
 - Glow plugs.
 - Valve keepers (406).
- Rotate the engine until the piston for the cylinder being serviced is at TDC.
 - Install J 26999-10 (C and K models) or J 26999-30 (K models with quad front shocks) into the glow plug hole.

- C. Apply compressed air to hold the valves in place.
- D. Use J 38606 to compress the valve spring (figure 16). If the spring will not compress, tap on the tool lightly with a mallet to break the cap or rotator loose from the valve keepers.
- E. Remove the valve keepers.
- F. Carefully release spring tension. Remove J 38606.
- 5. Cap or rotator, shield, and valve spring with damper.
- 6. Valve seals.

Install or Connect (Figures 15 and 16)

Tools Required:

- J 26999-10 Air Line Adaptor
- J 26999-30 Air Line Adaptor (K models with quad front shocks)
- J 38606 Valve Spring Compressor

- 1. New valve seals.
- 2. Valve spring with damper, shield, and cap or rotator.
- 3. Valve keepers.
 - A. With air pressure applied to the cylinder using J 26999-10 (C and K models) J 26999-30 (K models with quad front shocks), compress the valve spring with J 38606 (figure 16).
 - B. Install the valve keepers. Use grease to hold them in place.
 - C. Carefully release spring pressure. Make sure the valve keepers stay in place.
 - D. Remove J 38606 and J 26999-10 or J 29666-30.
- 4. Glow plugs.
- 5. Rocker arm shaft with rocker arms. Refer to "Rocker Arm Shaft, Rocker Arms and Pushrod Replacement."
- 6. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

CYLINDER HEAD REPLACEMENT

Tool Required:

- J 39083 Glow Plug Connector Remover/Installer

Remove or Disconnect

- 1. Intake manifold. Refer to "Intake Manifold Replacement."
- 2. Injection lines. Refer to SECTION 6C2.
- 3. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
 - Drain the cooling system.
 - Raise the vehicle and support with safety stands.
- 4. Exhaust pipe from the manifold.
 - Lower the vehicle.
- 5. Components as follows for right cylinder head.
 - Air conditioning compressor with bracket and lay aside.
 - Vacuum pump (if equipped) with bracket and lay aside.
 - Ground strap at the cowl.

6. Components as follows for left cylinder head:

- Power steering pump and lay aside.
- Generator and rear bracket and lay it aside.
- Left side engine accessory bracket.
- Wiring harness at the clips and move aside.
- Glow plug relay.
- Dipstick tube.
- 7. Wire from the coolant sensor at the cylinder head.
- 8. Glow plug wires. Use J 39083 to disconnect the glow plug connectors from the glow plugs. The connector cannot be reached with the hand. **Do not pull on the glow plug harness wire.**
- 9. Rocker arm assemblies and pushrods. Refer to "Rocker Arm Shaft, Rocker Arms, and Pushrod Replacement."

Important

- Rocker arm assemblies and pushrods must be marked for proper assembly.
- 10. Radiator, bypass, and heater hoses.
- 11. Ground straps.
- 12. Coolant crossover pipe/thermostat housing assembly.
- 13. Exhaust manifold.
- 14. Cylinder head bolts. Rear bolt in left cylinder head may have to remain in the head during removal.
- 15. Cylinder head.

CLEANING AND INSPECTION

Clean

- Carbon deposits from combustion chambers.
- All traces of old head gasket from cylinder head and block. Use of a motorized wire brush is not recommended.
- Cylinder head bolt threads using a wire brush.
- Metal chips and dirt from the threads in the block.

Inspect

- Cylinder head for cracks between the intake and exhaust ports. Use the magnaflux or dye method if available.
- Sealing surfaces of the block and cylinder head for nicks, heavy scratches, or other damage.
- Block for missing or damaged dowel pins or dowel pins in the wrong location.

Measure

- Cylinder head warpage. If warped more than 0.15 mm (0.006 inch) longitudinally or 0.08 mm (0.003 inch) transversely, replace the cylinder head. Resurfacing is not recommended.
- Pre-chamber installed depth. The pre-chamber should be flush to a maximum of 0.05 mm (0.002 inch) protrusion.
 - Make the measurement at two or more points on the pre-chamber where the prechamber seats on the head gasket shield and sealing ring.

- Measure the difference between the flat of the pre-chamber and the flat surface of the cylinder head.
- The pre-chamber must not protrude out of the cylinder head more than 0.05 mm (0.002 inch).
- The pre-chamber must not be recessed into the cylinder head.

CYLINDER HEAD REPAIR

- Refer to the Light Duty Truck Unit Repair Manual.



Install or Connect (Figure 17)

NOTICE: For steps 4 and 5, refer to "Notice" on page 6A6-1.

1. Head gasket to the block over the dowel pins.



Important

- The block gasket surfaces must be clean.
 - DO NOT use a sealer on the head gasket. The head gasket is manufactured with the proper amount of sealant "printed" on its surface. Additional sealer may cause leakage or malfunction. In addition, some sealers may attack the sealant already on the head gasket.
2. Rear cylinder head bolt to the cylinder head (left cylinder head). Apply sealant to the bolt as described in step 4. Due to clearances, the bolt must be installed at this time.
 3. Cylinder head. Make sure the gasket surfaces are clean. Guide the head carefully into place over the dowel pins.
 4. Cylinder head bolts.
 - A. Make sure the bolt threads are clean.
 - B. Apply sealant (GM P/N 1052080) or equivalent to the bolt threads and under the bolt heads.



Tighten

- Cylinder head bolts, as follows:
 - A. Using the sequence shown in figure 17, tighten all bolts to 25 N.m (20 lbs. ft.).
 - B. In sequence, tighten all bolts to 65 N.m (50 lbs. ft.).
 - C. In sequence, tighten all bolts an additional 90 degrees (1/4 turn).

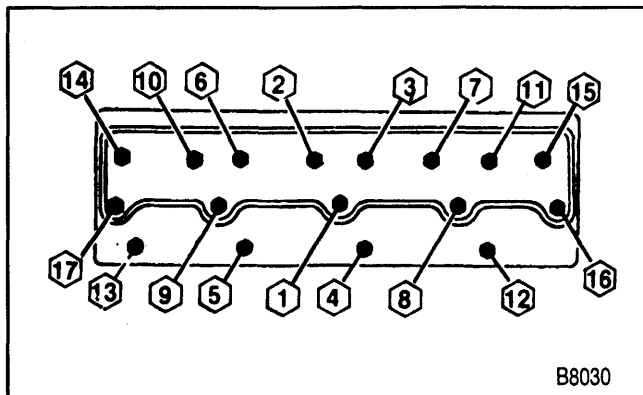


Figure 17—Head Bolt Tightening Sequence

5. Coolant crossover pipe/thermostat assembly. Use new gaskets.



Tighten

- Bolts to 42 N.m (31 lbs. ft.).
6. Ground strap.
 7. Radiator, bypass, and heater hoses.
 8. Pushrods and rocker arm assemblies, in their original locations, refer to "Rocker Arm Shaft, Rocker Arms, and Pushrod Replacement." Hardened ends of the pushrods must face up.
 9. Glow plug wires. Use J 39083 to connect the glow plug connectors to the glow plugs. The connector cannot be reached with the hand. **Do not pull on the glow plug harness wire.**
 10. Wire from the coolant sensor at the cylinder head.
 11. Components as follows for right cylinder head.
 - Air conditioning compressor with bracket.
 - Ground strap at the cowl.
 12. Components as follows for left cylinder head:
 - Power steering pump.
 - Generator and rear bracket.
 - Left side engine accessory bracket.
 - Wiring harness at the clips.
 - Glow plug relay.
 - Dipstick tube.
 - Raise the vehicle and support with safety stands.
 13. Exhaust pipe to the manifold.
 - Lower the vehicle.
 14. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
 15. Injection lines. Refer to SECTION 6C2.
 16. Intake manifold. Refer to "Intake Manifold Replacement."
 - Fill the cooling system with the proper quantity and grade of coolant.

OIL PUMP DRIVE REPLACEMENT

NOTICE: Do not run the engine without the oil pump drive in place. This will cause extensive engine damage.



Remove or Disconnect (Figure 18)

1. Negative battery cables. Refer to SECTION 0A.
2. Air cleaner.
 - Move the wiring harness aside.
3. Bolt and clamp.
4. Oil pump drive.
5. Gasket.



Install or Connect (Figure 18)

1. New gasket to the oil pump drive.
2. Oil pump drive to the engine. Index the drive with the camshaft gear and oil pump drive shaft. Make sure the drive seats fully.

NOTICE: Refer to "Notice" on page 6A6-1.

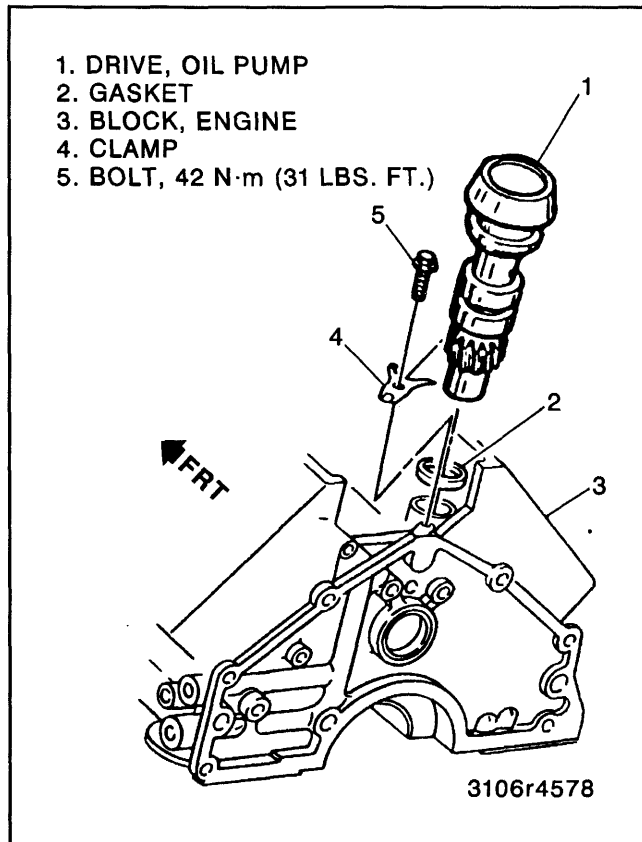


Figure 18—Oil Pump Drive

3. Clamp and bolt.



Tighten

- Bolt to 42 N·m (31 lbs. ft.).

4. Wiring harness.
5. Air cleaner.
6. Negative battery cables.

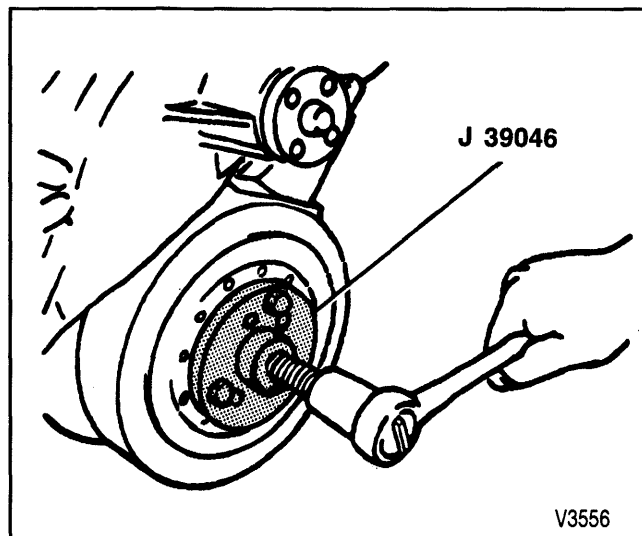


Figure 19—Removing the Torsional Damper

TORSIONAL DAMPER AND FRONT CRANKSHAFT SEAL REPLACEMENT



Remove or Disconnect (Figures 19 and 20)

Tool Required:

J 39046 Torsional Damper Puller

1. Negative battery cables. Refer to SECTION 0A.
2. Accessory drive belt.
3. Bolts and crankshaft pulley.
4. Torsional damper bolt and washer.
5. Torsional damper. Use J 39046 (figure 19).
6. Front crankshaft seal. Pry out with a screwdriver.



Install or Connect (Figure 20)

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A6-1.

Tool Required:

J 22102 Seal Installer

1. New front crankshaft seal. Use J 22102 (figure 20). Lubricate the seal lips with engine oil.
- Apply engine oil to the crankshaft stub.
2. Torsional damper. Tap into place with a mallet. Make sure the key is in place. Make sure the damper is all the way on the crankshaft.
3. Torsional damper bolt and washer.



Tighten

- Bolt to 270 N·m (200 lbs. ft.).
4. Crankshaft pulley and bolts.



Tighten

- Bolts to 40 N·m (30 lbs. ft.).
5. Accessory drive belt.
6. Negative battery cables.

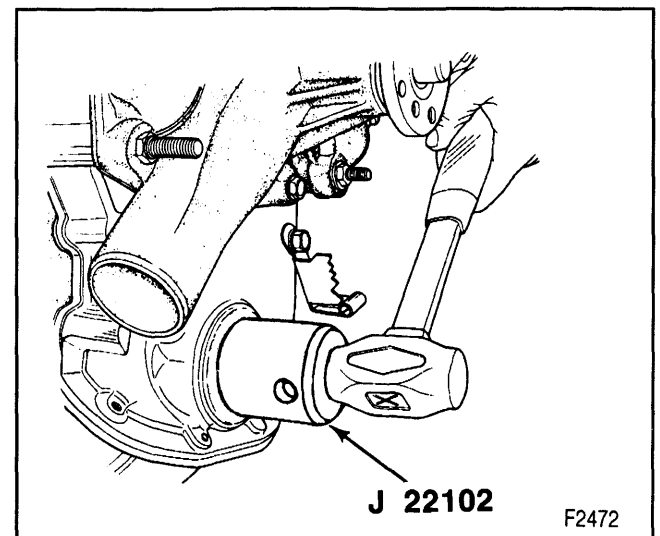


Figure 20—Installing the Front Crankshaft Seal

FRONT COVER REPLACEMENT

↔ Remove or Disconnect (Figures 21 and 22)

- Drain the cooling system.
- 1. Coolant pump. Refer to SECTION 6B.
- Rotate the engine until the timing marks on the pump gear and camshaft gear are aligned (figure 22).
- Scribe a mark aligning the injection pump flange and front cover.

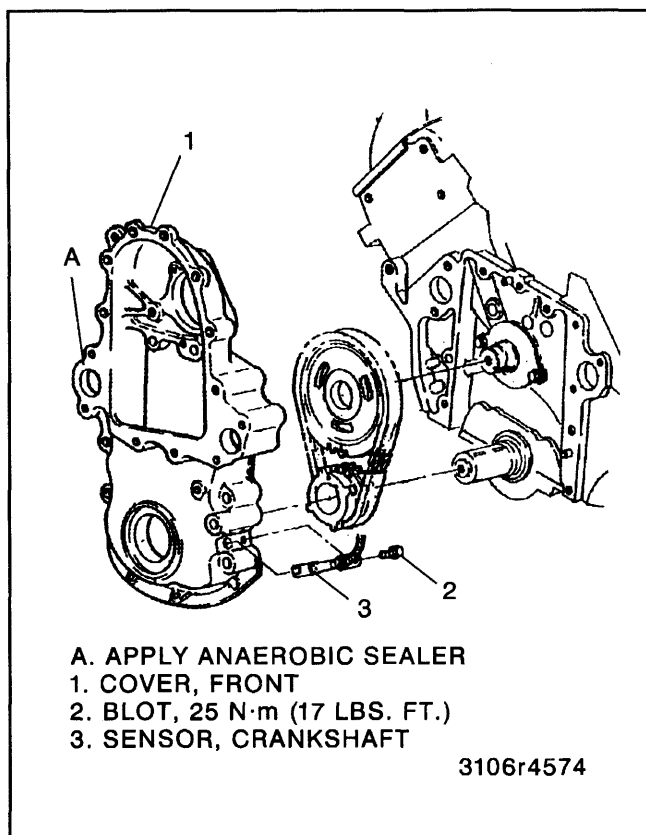


Figure 21—Front Cover and Components

2. Torsional damper. Refer to "Torsional Damper and Front Crankshaft Seal Replacement."
3. Four front cover to oil pan bolts.
4. Two fuel return line clips.
5. Injection pump gear.
6. Injection pump retaining nuts at the front cover.
7. Baffle.
8. Front cover bolts.
9. Front cover.
10. Front crankshaft seal. Pry out with a screwdriver.



Clean

- RTV from oil pan sealing surface.
- Sealing surfaces on front cover.



Inspect

- Front cover for cracks or damage to sealing surfaces.



Install or Connect (Figures 20, 21 and 22)

NOTICE: For steps 2 through 5, refer to "Notice" on page 6A6-1.

Tool Required:

J 22102 Seal Installer

1. New front crankshaft seal to the front cover. Use J 22102 (figure 20)
 - Apply a 2-mm (3/32-inch) bead of anaerobic sealant (GM P/N 1052357) or equivalent to the front cover sealing area shown in (figure 21).
 - Apply a 5-mm (3/16-inch) bead of RTV sealant to the front cover sealing surface that mates against the oil pan.
2. Front cover to the engine. Install the attaching bolts.



Tighten

- Front cover to block bolts to 45 N·m (33 lbs. ft.).
- Oil pan to front cover bolts to 10. N·m (89 lbs. in.).

3. Baffle.

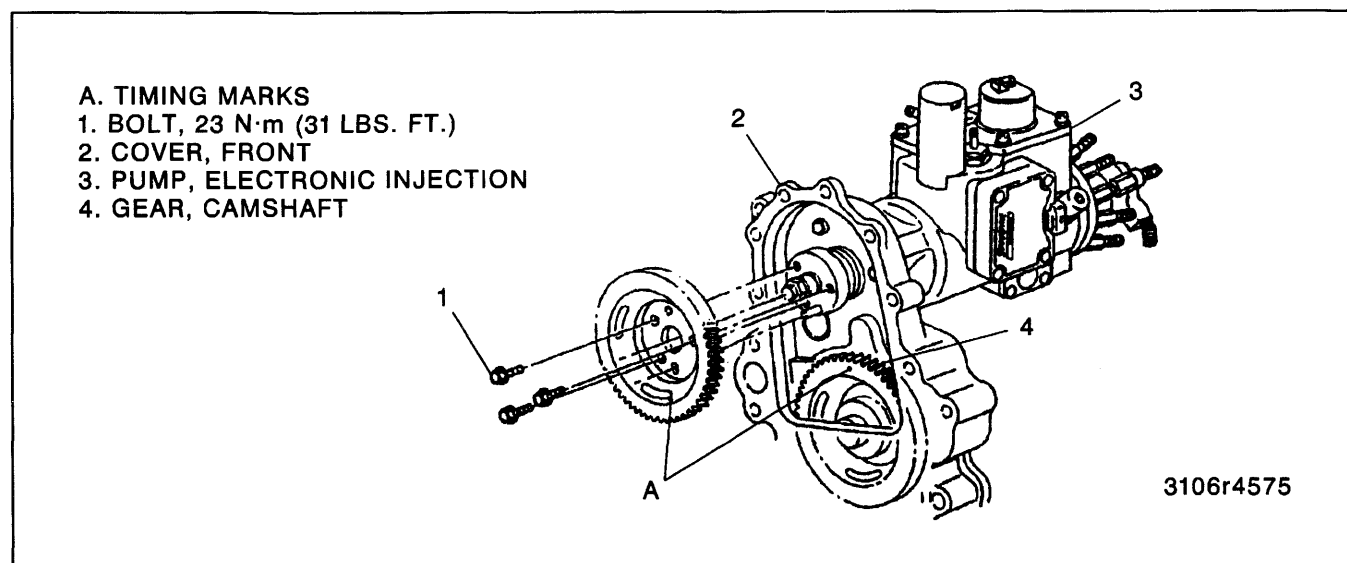


Figure 22—Injection Pump Gear and Timing Marks



Tighten

- Baffle bolts and nut to 45 N·m (33 lbs. ft.).
 - Align the scribe marks on the front cover and injection pump. If a new front cover was installed, refer to "Marking TDC on the Front Housing" in SECTION 6C2.
4. Injection pump nuts.



Tighten

- Nuts to 42 N·m (31 lbs. ft.).
5. Injection pump gear and bolts. Align the timing marks.



Tighten

- Injection pump gear bolts to 23 N·m (17 lbs. ft.).



Measure

- Clearance between injection pump gear and baffle (figure 22). It is necessary to maintain a minimum of 1.0 mm (0.040 inch) between the gear and baffle or noise may result.
6. Fuel return line clip screws.
7. Torsional damper. Refer to "Torsional Damper and Front Crankshaft Seal Replacement."
8. Coolant pump. Refer to SECTION 6B.
• Fill the cooling system with the proper quantity and grade of coolant.

TIMING CHAIN AND SPROCKET REPLACEMENT



Remove or Disconnect (Figure 23)

1. Front cover. Refer to "Front Cover Replacement."



Measure

- Timing chain free play as follows:
- A. Mount a dial indicator to the front of the block.

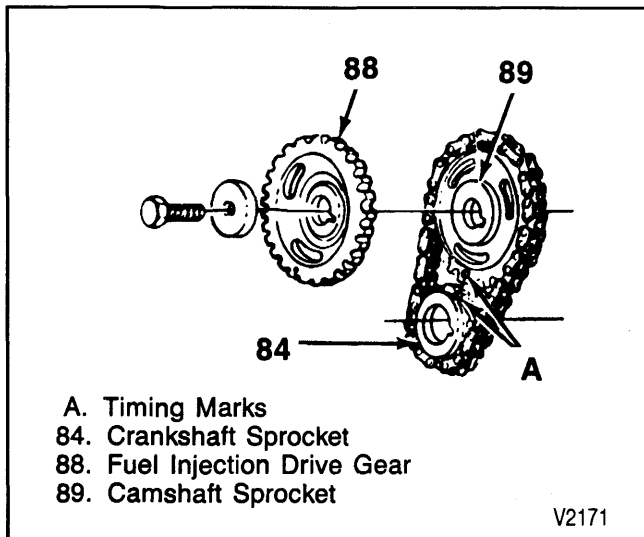


Figure 23—Timing Chain and Sprockets

- B. Position the dial indicator so the plunger contacts the timing chain between the two gears.
C. Pull the chain outward (parallel to the front face of the block) the maximum amount with finger pressure on the inside of the chain.
D. Set the dial indicator to zero.
E. Move the chain inward (parallel to the front face of the block) the maximum amount with finger pressure on the outside of the chain.
F. Note the total indicator travel. With used parts, the deflection must not exceed 20.3 mm (0.8 inch). If the deflection exceeds this limit, the sprockets and timing chain must be inspected for wear and replaced as necessary. With new parts the maximum deflection must not exceed 12.7 mm (0.5 inch).
2. Injection pump gear.
3. Camshaft gear.
• Align the timing marks (figure 23).
4. Camshaft sprocket with timing chain.
5. Crankshaft sprocket.



Install or Connect (Figure 23)

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A6-1.

1. Crankshaft sprocket.
2. Camshaft sprocket with timing chain.



Important

- Align the timing marks (figure 23).
3. Camshaft gear, bolt, and washer.



Tighten

- Bolt to 100 N·m (75 lbs. ft.).
4. Injection pump gear and bolts.



Important

- Align the timing marks (figure 23).



Tighten

- Bolts to 23 N·m (17 lbs. ft.).
5. Front cover. Refer to "Front Cover Replacement."



Adjust

- Injection pump timing, if new gears, sprockets, or timing chain were installed. Refer to SECTION 6C2.

CAMSHAFT REPLACEMENT



Remove or Disconnect (Figure 24)

1. Negative battery cables. Refer to SECTION 0A.
• Drain the cooling system.
2. Radiator, shrouds, and fan.
3. Grille and parking lamp assembly.

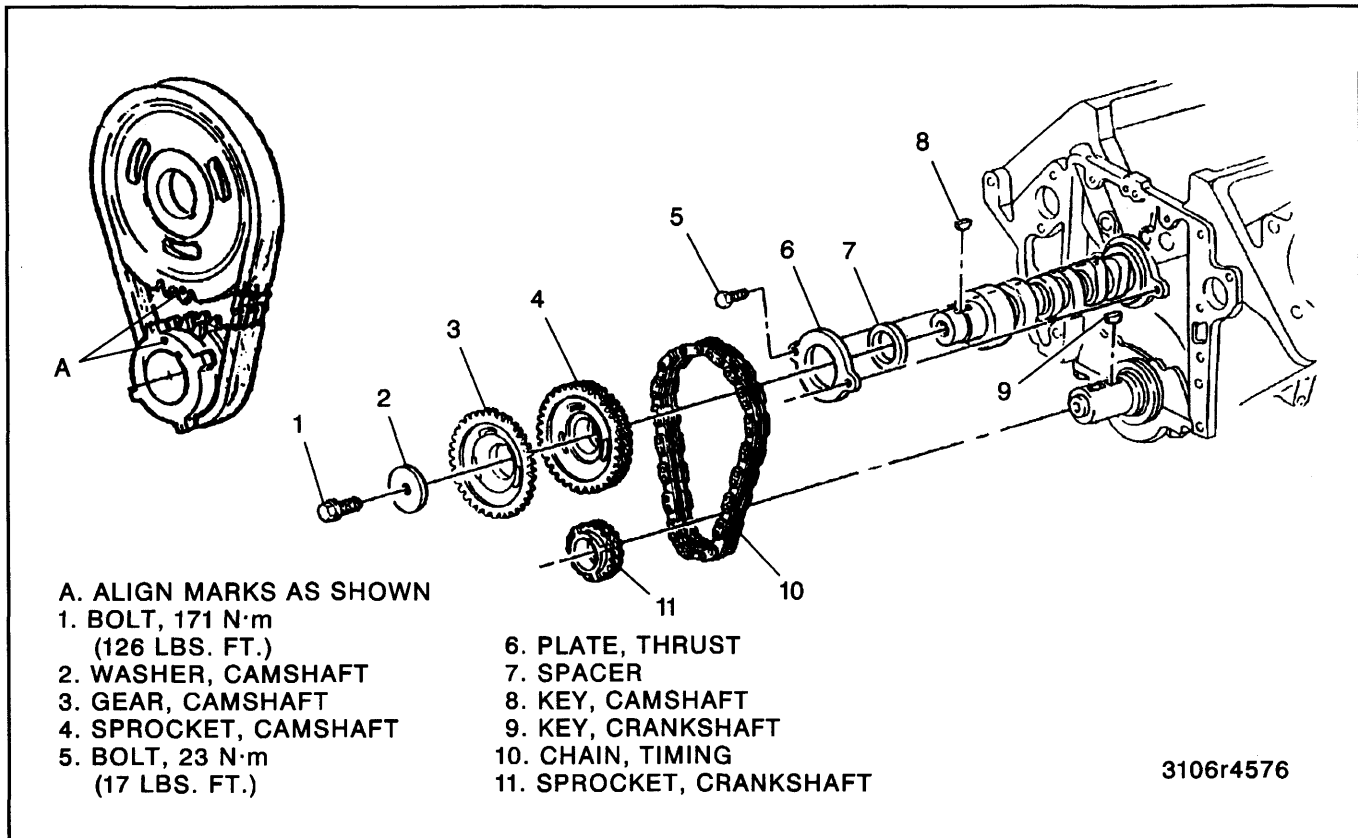


Figure 24—Camshaft and Components

4. Hood latch and brace assembly.
5. Oil pump drive. Refer to "Oil Pump Drive Replacement."
6. Power steering pump, generator, and air conditioning compressor and position aside.
7. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."
8. Rocker arm assemblies and pushrods. Refer to "Rocker Arm Shaft, Rocker Arms, and Pushrod Replacement."

! Important

- Rocker arm assemblies and pushrods must be marked for proper assembly.
9. Hydraulic lifters. Refer to "Hydraulic Lifter Replacement." Place the lifters in an organizer rack. The lifters must be installed in the same bore from which they were removed.
 10. Front cover. Refer to "Front Cover Replacement."
 11. Timing chain and camshaft sprocket. Refer to "Timing Chain and Sprocket Replacement."
 12. Front engine mounting through bolts.

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Raise the engine and block in position.

13. Air conditioning condenser mounting bolts (if equipped). Lift the condenser with the aid of an assistant.
14. Bolts and thrust plate.
15. Camshaft. Pull the camshaft from the block carefully to avoid damage to the camshaft bearings.
16. Spacer (if necessary).

CLEANING, INSPECTION, AND REPAIR

Clean, inspect, and repair or replace the camshaft and related components. Refer to the Light Duty Truck Unit Repair Manual.

The Light Duty Truck Unit Repair Manual also describes camshaft bearing replacement.

- ⇄ Install or Connect (Figures 23, 24, and 35 or 36)**

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A6-1.

- When a new camshaft is installed, replacement of all hydraulic lifters, engine oil, and oil filter is recommended.

1. Spacer, with the ID chamfer towards the camshaft.
2. Camshaft.
 - A. Coat the camshaft lobes with camshaft and lifter Pre Lube (GM P/N 1052365) or equivalent.
 - B. Lubricate the camshaft bearing journals with engine oil.

C. Insert the camshaft carefully into the block to avoid damage to the camshaft bearings.

3. Thrust plate and bolts.



Tighten

- Bolts to 23 N·m (17 lbs. ft.).

- Lower the engine.

4. Engine mounting through-bolts and nuts.



Tighten

- Bolts to 95 N·m (70 lbs. ft.) or nuts to 70 N·m (50 lbs. ft.).

5. Timing chain and sprockets. Refer to "Timing Chain and Sprocket Replacement."



Important

- Align the timing marks (figure 23).

6. Air conditioning condenser (if equipped).

7. Fuel pump (lift pump).

8. Front cover. Refer to "Front Cover Replacement."

9. Hydraulic lifters. Refer to "Hydraulic Lifter Replacement." Used lifters must be installed in the same bore from which they were removed.

10. Rocker arm assemblies and pushrods, in their original locations. Refer to "Rocker Arm Shaft, Rocker Arms, and Pushrod Replacement." Hardened ends of the pushrods must face up.

11. Rocker arm covers. Refer to "Rocker Arm Cover Replacement."

12. Power steering pump, generator, and air conditioning compressor, as equipped.

13. Oil pump drive. Refer to "Oil Pump Drive Replacement."

14. Hood latch and brace assembly

15. Grille and parking lamp assembly

16. Fan, radiator, and radiator shrouds.

17. Negative battery cables.

- Fill the cooling system with the proper quantity and grade of coolant.

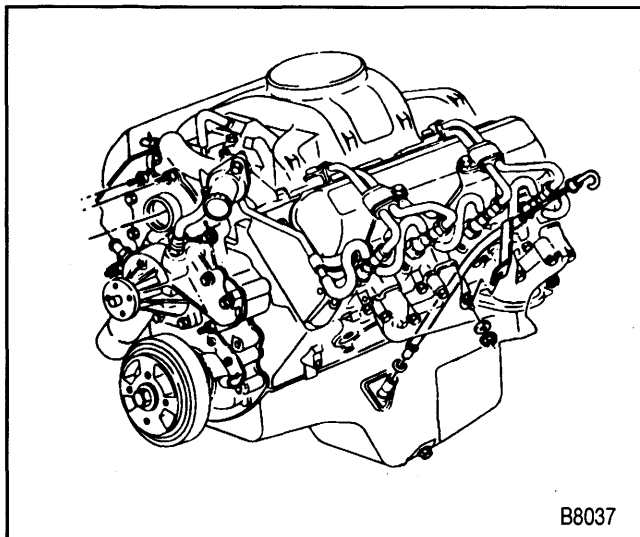


Figure 25—Oil Dipstick Tube

DIPSTICK TUBE REPLACEMENT



Remove or Disconnect (Figure 25)

1. Negative battery cables. Refer to SECTION 0A.
2. Dipstick tube bracket, nut, and washer, at the exhaust manifold.
3. Dipstick tube.
4. O-ring seal from the dipstick tube.



Install or Connect (Figure 25)

1. New O-ring seal to the dipstick tube.
2. Dipstick tube to the engine.
3. Dipstick tube bracket nut and washer.
4. Negative battery cables.

OIL PAN REPLACEMENT



Remove or Disconnect (Figure 26)

1. Negative battery cables. Refer to SECTION 0A.
 - Raise the vehicle and support with safety stands.
 - Drain the engine oil.
2. Flywheel cover.
3. Exhaust pipes from the manifold.
4. Front engine mounting through-bolts.

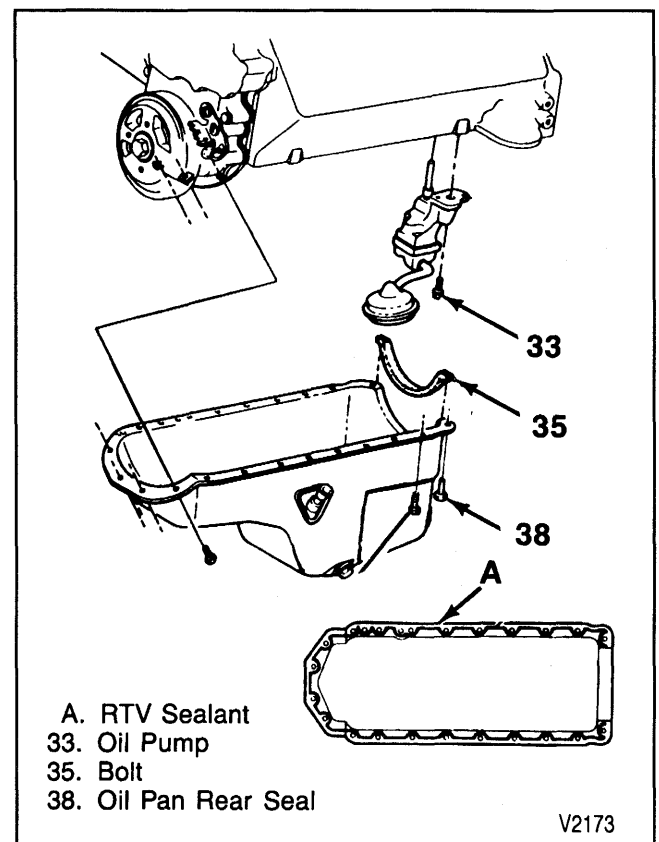


Figure 26—Oil Pan and Oil Pump

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Raise the engine.
- 5. Oil pan bolts.
- 6. Oil pan.
- 7. Oil pan rear seal.



Clean

- Old RTV from the oil pan and block.
- All oil and grease from the gasket surfaces.



Install or Connect (Figure 26)

NOTICE: For steps 3 and 4, refer to "Notice" on page 6A6-1.

- Apply a 5-mm (3/16-inch) bead of RTV sealant (GM P/N 1052915) or equivalent to the oil pan sealing surface, inboard of the bolt holes (figure 26). The sealer must be wet to the touch when the oil pan is installed.
- 1. Oil pan rear seal.
- 2. Oil pan to the engine. Be sure to connect the oil dipstick.
- 3. Oil pan bolts.



Tighten

- All except rear two bolts to 10 N.m (89 lbs. in.).
- Rear two bolts to 23 N.m (17 lbs. ft.).
- Lower the engine.
- 4. Engine mounting through-bolt and nut.



Tighten

- Bolt to 95 N.m (70 lbs. ft.) or nut to 70 N.m (50 lbs. ft.).
- 5. Exhaust pipes to manifolds.
- 6. Flywheel cover.
- Lower the vehicle.
- 7. Proper quantity and grade of engine oil.
- 8. Negative battery cables.

OIL PUMP REPLACEMENT



Remove or Disconnect (Figure 26)

1. Oil pan. Refer to "Oil Pan Replacement."
2. Oil pump to main bearing cap bolt.
3. Oil pump and extension shaft.



Inspect

- Oil pump pick up tube and screen for damage.
- Oil pump extension shaft bushing for cracks.

OIL PUMP REPAIR

- The oil pump is serviced only as a unit.



Install or Connect (Figure 26)

1. Oil pump and extension shaft to the engine. Align the extension shaft hex with the drive hex on the oil pump drive or vacuum pump. The oil pump should push easily into place.

NOTICE: Refer to "Notice" on page 6A6-1.

2. Oil pump bolt.



Tighten

- Oil pump bolt to 90 N.m (65 lbs. ft.).
- 3. Oil pan. Refer to "Oil Pan Replacement."

REAR CRANKSHAFT OIL SEAL REPLACEMENT

Tools Required:

J 39084 Rear Main Seal Installer

Before a new seal is installed, the CDR and crankcase ventilation system should be thoroughly inspected and crankcase pressure should be checked. Refer to SECTION 6E2.



Remove or Disconnect (Figure 27)

1. Transmission. Refer to SECTION 7.
2. Flywheel.
3. Oil seal using oil seal removal tool. Do not reuse old seal.



Clean

- Clean the oil seal bore in the block thoroughly before installing a new oil seal.



Inspect

- The rear portion of the crankshaft where the oil seal makes contact for wear due to the rubbing action of the oil seal or dirt buildup. Correct as necessary.



Important

- The crankshaft surface must be clean and smooth to prevent damaging the seal lip when a new oil seal is installed.
- Because of rear crankshaft wear or grooving, the service seal will be positioned flush with the rear block face. The position of the new seal will be controlled by the installation tool J 39084. The reason for the positioning of the seal in a new location is to provide a new surface for the oil seal to ride on.

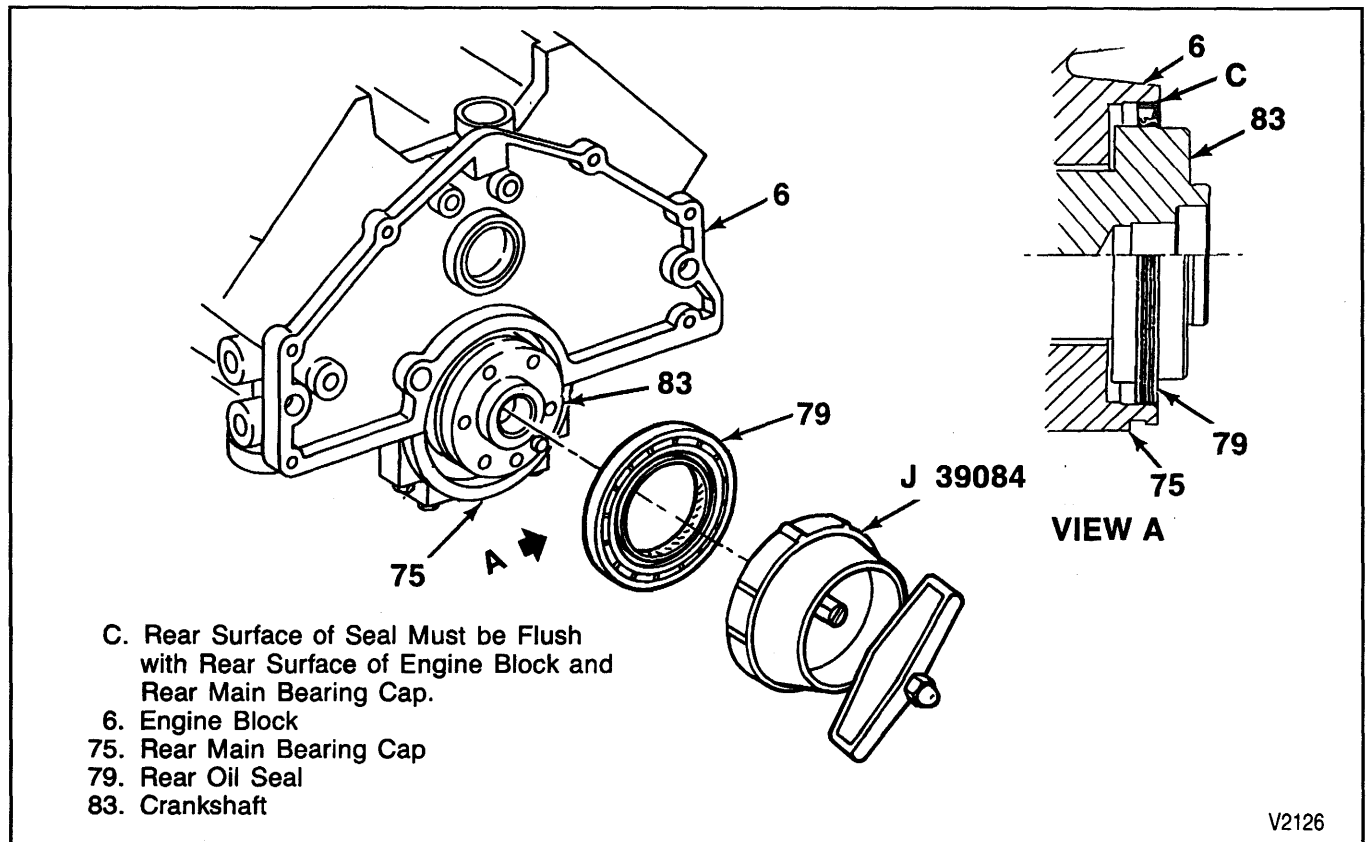


Figure 27—Installing the Rear Main Seal

Install or Connect (Figure 27)

Important

- Coat the crankshaft surface with engine oil, and lightly coat the lip of the new oil seal with engine oil or grease before installing the new oil seal. Do not scratch or nick the sealing edge of the oil seal.
1. The oil seal, with the spring cavity towards the engine, onto the crankshaft.
 2. Using J 39084, drive the seal in until the tool bottoms against the block and rear main bearing cap.
 3. Flywheel.
 4. Transmission. Refer to SECTION 7.

CONNECTING ROD AND PISTON REPLACEMENT

Remove or Disconnect (Figure 28)

1. Cylinder head. Refer to "Cylinder Head Replacement."
2. Oil pan. Refer to "Oil Pan Replacement."
3. Oil pump. Refer to "Oil Pump Replacement."
4. Ridge or deposits from the upper end of the cylinder bores.
 - A. Turn the crankshaft until the piston is at BDC.
 - B. Place a cloth on top of the piston.
 - C. Perform the cutting operation with a ridge reamer.

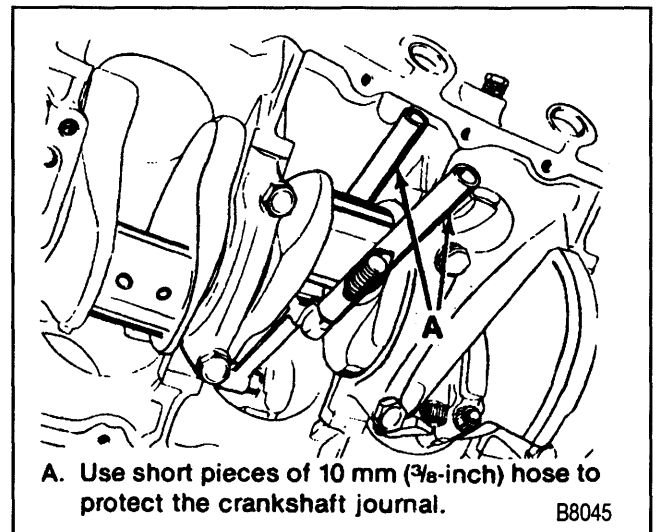


Figure 28—Replacing the Connecting Rod and Piston

- D. Turn the crankshaft until the piston is at TDC.
 - E. Remove the cloth and cuttings.
5. Connecting rod cap. Check the connecting rod and cap for identification marks. Mark the parts if required. The connecting rod and cap must be kept together as mating parts.
 6. Connecting rod and piston.
 - A. Attach two short pieces of 10-mm (3/8-inch) hose to the connecting rod bolts (figure 28). This will protect the crankshaft journal during removal.

- B. Push the connecting rod and piston out of the bore.
7. Connecting rod bearings. Place the bearings in a rack, if they are to be reused, so they can be returned to their original locations.

CLEANING, INSPECTION, AND REPAIR

Clean, inspect, and repair or replace the components as necessary. Measure connecting rod bearing clearance, piston clearance, ring clearances, etc. Refer to the Light Duty Truck Unit Repair Manual.

The Light Duty Truck Unit Repair Manual contains information on:

- Connecting rod and piston.
- Piston rings.
- Connecting rod and crankpin.
- Cylinder bores.

Install or Connect (Figures 27 through 31)

Tool Required:

J 8037 Ring Compressor

- Make sure the cylinder walls are clean. Lubricate the cylinder wall lightly with engine oil.
 - Make sure the piston is installed in the matching cylinder. Install new pistons in the cylinders for which they were fitted. Install used pistons in the cylinder from which they were removed.
1. Connecting rod bearings.
 - A. Make sure that the bearings are the proper size.
 - B. Install the bearings in the connecting rod and connecting rod cap.
 - C. Lubricate the bearings with engine oil.
 2. Piston and connecting rod to the proper bore.
 - A. With the connecting rod cap removed, install two short pieces of 10-mm (3/8-inch) hose onto the connecting rod studs (figure 28).
 - B. Locate the piston ring end gaps as shown in figure 29. Lubricate the piston and rings with engine oil.
 - C. Without disturbing the ring end gap location, install J 8037 over the piston (figure 30).
 - D. The piston must be installed so that the depression in the piston crown is toward the outside of the engine. The connecting rod bearing tang slots must be opposite the camshaft.
 - E. Place the piston in its matching bore. Using light blows with a hammer handle, tap the piston down into its bore (figure 30). At the same time, from beneath the vehicle, guide the connecting rod to the crankpin with the pieces of hose. Hold the ring compressor against the block until all rings have entered the cylinder bore.
 - F. Remove the hoses from the connecting rod bolts.

Measure

- Connecting rod bearing clearance. Refer to the Light Duty Truck Unit Repair Manual.
3. Connecting rod cap and bearing.

4. Connecting rod cap nuts.

Tighten

- Connecting rod cap nuts to 65 N.m (48 lbs. ft.).

Measure

- Connecting rod side clearance. Use a feeler gage between the connecting rod and crankshaft (figure 31). The correct clearance is 0.17-0.63 mm (0.0067-0.0248 inch).
5. Oil pump (if removed). Refer to "Oil Pump Replacement."
 6. Oil pan and cylinder head. Refer to "Oil Pan Replacement" and "Cylinder Head Replacement."

MAIN BEARING REPLACEMENT

Remove or Disconnect (Figure 32)

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Glow plugs.
2. Oil pan. Refer to "Oil Pan Replacement."
3. Oil pump. Refer to "Oil Pump Replacement."
4. Main bearing caps.
 - Check the main bearing caps for location markings. Mark the caps if necessary. The caps must be returned to their original locations during assembly.
5. Lower main bearing inserts from the main bearing caps.

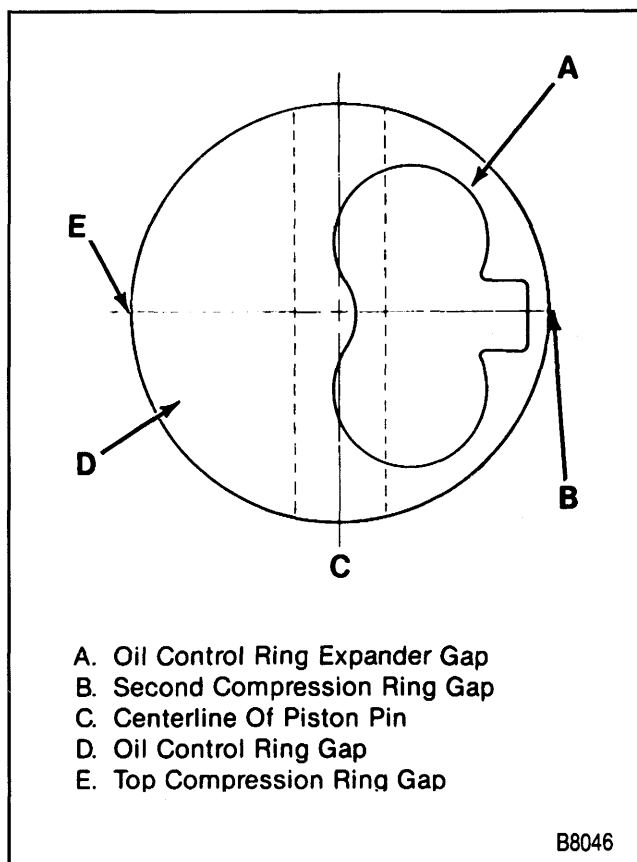


Figure 29—Ring Gap Location

NOTICE: Refer to "Notice" on page 6A6-1.

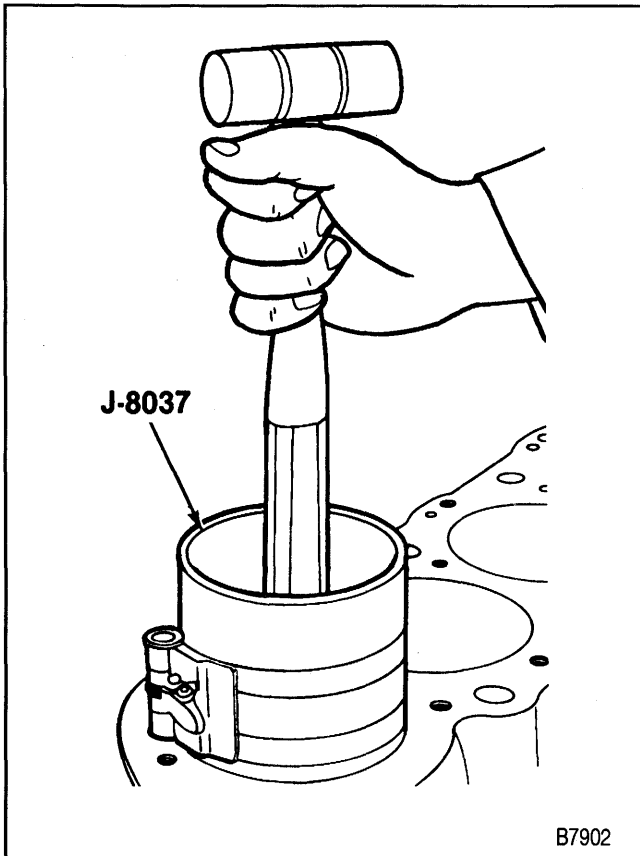


Figure 30—Installing the Piston and Connecting Rod

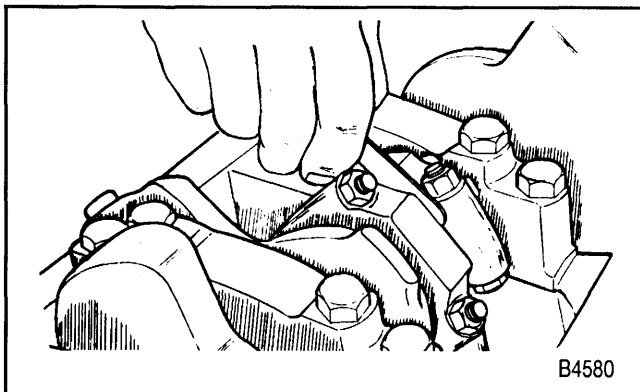


Figure 31—Checking Connecting Rod Side Clearance

6. Rear crankshaft oil seal if necessary. Refer to "Rear Crankshaft Oil Seal Replacement."
7. Upper main bearing inserts.
 - A. Insert J 8080 into the crankshaft oil hole (figure 32).
 - B. Rotate the crankshaft to "turn" the bearing insert out of the block.

CLEANING, INSPECTION, AND REPAIR

Clean, inspect, and repair or replace the components as required. Refer to the Light Duty Truck Unit Repair Manual. The Light Duty Truck Unit Repair Manual contains information on:

- Crankshaft.
- Main and connecting rod bearings.

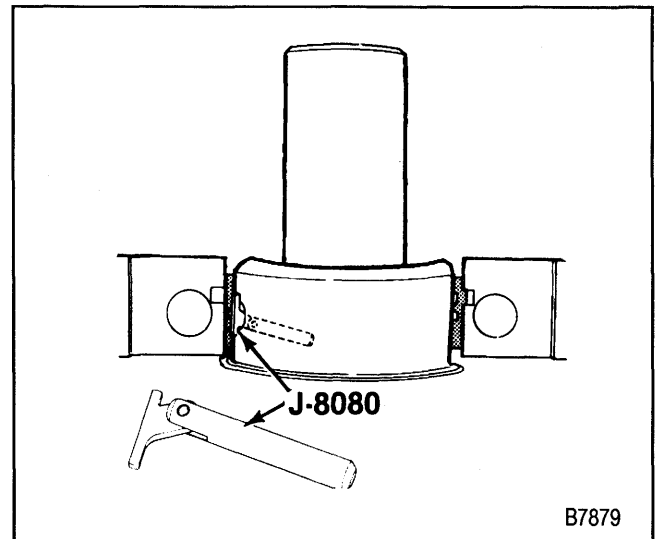


Figure 32—Removing the Main Bearings



Install or Connect (Figures 32 and 33)

Tool Required:

J 8080 Main Bearing Remover/Installer

1. Upper main bearing inserts.
 - A. Insert tool J 8080 into a crankshaft main bearing oil hole (figure 32).
 - B. Apply engine oil to inserts of the proper size.
 - C. Insert the plain end (without the bearing tang) of the insert between the crankshaft and the notched side of the block.

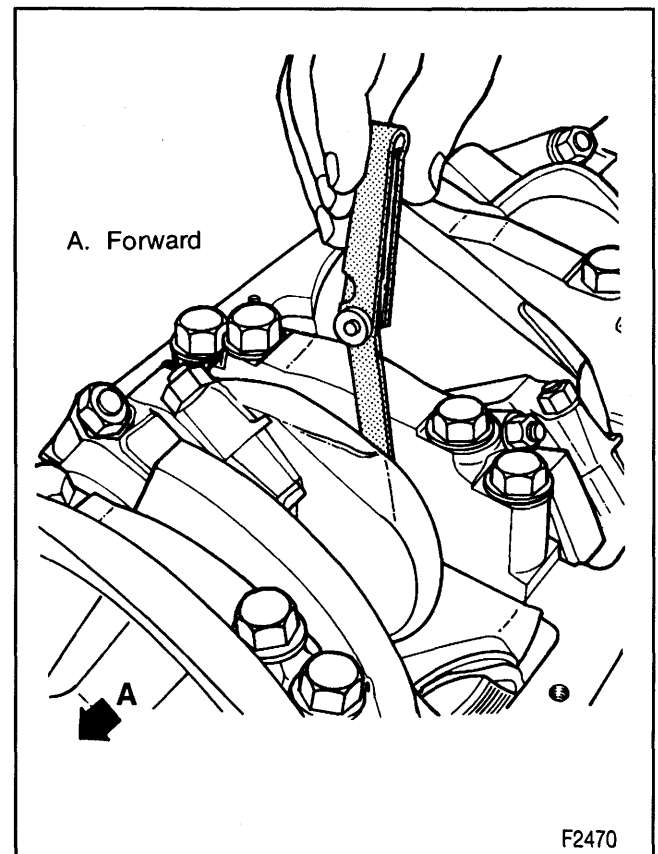


Figure 33—Measuring Crankshaft End Play

- D. Rotate the crankshaft to "roll" the insert into the block.
- E. Remove J 8080.
- 2. Lower main bearing inserts to the main bearing caps.
 - A. Make sure the inserts are of the proper size.
 - B. Apply engine oil to the inserts.



Measure

- Main bearing clearance. Refer to the Light Duty Truck Unit Repair Manual. If the engine is in the vehicle, the crankshaft must be supported upward to remove any clearance from the upper bearing. The total clearance can then be measured between the lower bearing and journal.
- 3. Rear crankshaft oil seal (if necessary). Refer to "Rear Crankshaft Oil Seal Replacement."

NOTICE: Refer to "Notice" on page 6A6-1.

NOTICE: The main bearing caps are to be tapped into place with a brass or leather mallet before the attaching bolts are installed. Do not use the attaching bolts to pull the main bearing caps into their seats, as this may damage the bearing cap and/or block.

- 4. Number 5 (rear) main bearing cap.
 - A. Apply a thin film of anaerobic sealant (GM P/N 1052756) or equivalent to the bearing cap. Keep the sealant off the seal and bearing. Do not put sealant in the bearing cap oil relief slot.
 - B. Apply a light coat of engine oil to the crankshaft surface that will contact the seal.
 - C. Apply engine oil to the main bearing cap bolt threads.
 - D. Tap the main bearing cap into place with a brass or leather mallet. Then install the bolts.



Tighten

- Bolts to specifications, in the following sequence:
 - A. Inner bolts: 150 N.m (110 lbs. ft.).
 - B. Outer bolts: 135 N.m (100 lbs. ft.).
 - C. Re-tighten all bolts in the same sequence.

- 5. Numbers 1, 2, and 4, main bearing caps and bolts.



Tighten

- Bolts to specifications. Refer to step 4.

- 6. Number 3 (center) main bearing cap and bolts. Tighten the bolts temporarily to 14 N.m (124 lbs. in.).



Measure

- Crankshaft end play, as follows:
 - A. Tap the end of the crankshaft first rearward then forward with a lead hammer. This will line up the rear main bearing and crankshaft thrust surfaces.

- B. Tighten the rear main bearing cap bolts to specifications. Refer to step 4.
- C. With the crankshaft forced forward, measure at the front end of the number 3 main bearing with a feeler gage (figure 33). The proper clearance is 0.10-0.25 mm (0.0039-0.0098 inch).

- 7. Oil pump. Refer to "Oil Pump Replacement."
- 8. Oil pan. Refer to "Oil Pan Replacement."
- 9. Glow plugs.

OIL FILTER BYPASS VALVE REPLACEMENT



Remove or Disconnect (Figure 34)

- 1. Oil filter.
- 2. Oil filter bypass valve. Pry out with a screwdriver.



Clean

- Recess in the block.

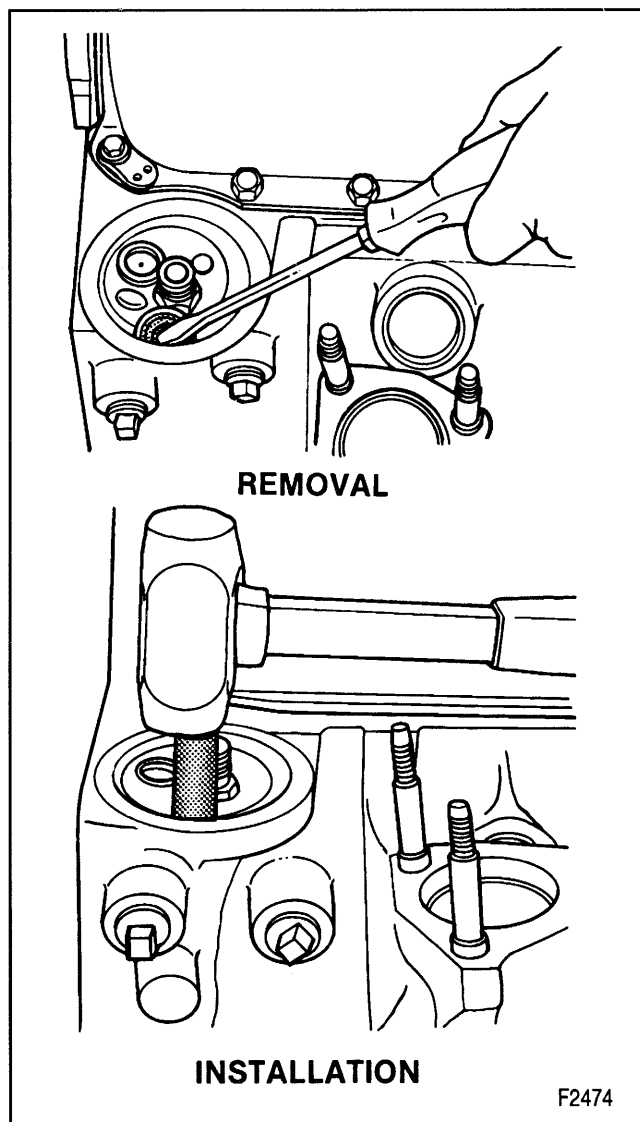


Figure 34—Replacing the Oil Filter Bypass Valve



Install or Connect (Figure 34)

1. Oil filter bypass valve. Tap into place using a 16-mm socket.
2. Oil filter.
3. Engine oil, as required.

ENGINE MOUNTINGS

NOTICE: Broken or deteriorated mountings can cause misaligned and eventual destruction of certain drive train components. When a single mounting breakage occurs, the remaining mountings are subjected to abnormally high stresses.

INSPECTING ENGINE MOUNTINGS

Front Engine Mountings

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

1. Raise the engine to remove weight from the mountings and to place a slight tension on the rubber cushion. Observe both mountings while raising the engine.
2. Replace the mounting if any of the following conditions exist:
 - Hard rubber surface covered with heat check cracks.
 - Rubber cushion separated from the metal plate of the mounting.
 - Rubber cushion split through the center.
3. If there is movement between a metal plate of the mounting and its attaching points, lower the engine and tighten the bolts or nuts attaching the mounting to the engine, frame, or bracket.

Rear Mountings

1. Push up and pull down on the transmission tailshaft. Observe the transmission mounting.
2. Replace the mounting if either of the following conditions exist:
 - Rubber cushion separated from the metal plate of the mounting.
 - Mounting bottomed out (tailshaft can be moved up but not down).
3. If there is relative movement between a metal plate of the mounting and its attaching point, tighten the bolts or nuts attaching the mounting to the transmission or crossmember.

FRONT ENGINE MOUNTING REPLACEMENT



Remove or Disconnect (Figures 35, 36, and 37)

1. Upper fan shroud
 - Raise the vehicle and support with safety stands.
2. Engine mounting through-bolts on both sides.

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Raise the engine and block into position.
3. Lower control arm at pivot point. Refer to SECTION 3C.
 4. Engine mounting to frame bolts.
 5. Engine mounting.



Install or Connect (Figure 35, 36, and 37)

NOTICE: For steps 2 and 3, refer to "Notice" on page 6A6-1.

1. Engine mounting to the frame.
2. Engine mounting to frame bolts and nuts.

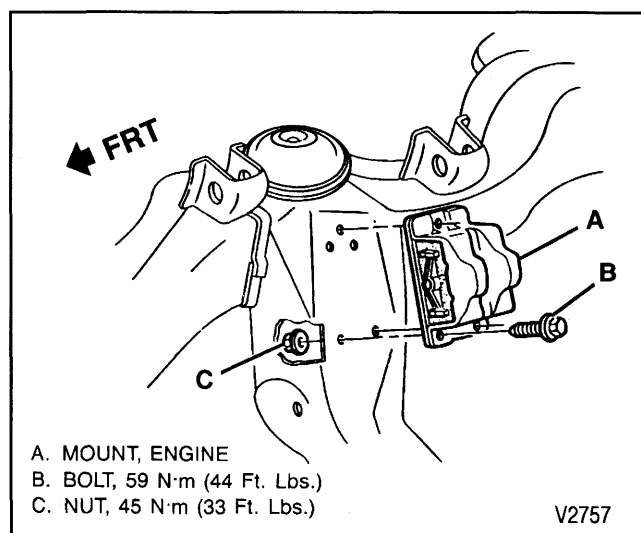


Figure 35—Front Engine Mounting (2WD Models)

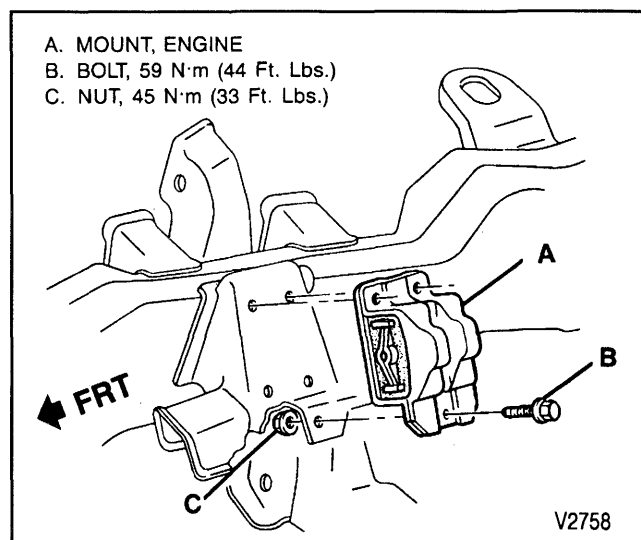


Figure 36—Front Engine Mounting (4WD Models)



Tighten

- Nuts to 48 N.m (36 lbs. ft.)
 - Lower the engine.
3. Engine mounting through-bolts.



Tighten

- Through-bolts to 95 N.m (70 lbs. ft.) or nuts to 70 N.m (50 lbs. ft.).
4. Lower control arm. Refer to SECTION 3C.
5. Upper fan shroud.

REAR MOUNTING REPLACEMENT



Remove or Disconnect (Figure 38 or 39)

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, resulting in a damaged oil pickup unit.

- Support the rear of the engine to relieve the weight on the rear mountings.
1. Mounting to crossmember nut(s) and washer(s).
 2. Mounting to transmission bolts and washers.
 - Raise the rear of the engine only enough to allow removal of the mounting.
 3. Mounting.



Install or Connect (Figure 38 or 39)

1. Mounting.
- Lower the rear of the engine.
2. Mounting to transmission bolts and washers.

NOTICE: Refer to "Notice" on page 6A6-1.



Tighten

- Fasteners to specifications. Refer to legends on figures 38 and 39.

ENGINE REPLACEMENT



Remove or Disconnect

Tool Required:

J 29664 Manifold Cover Set

1. Negative battery cables. Refer to SECTION 0A.
- Raise the vehicle and support with safety stands.
2. Flywheel cover.
3. Flywheel to torque converter bolts.
4. Exhaust pipes at the manifolds.
5. Starter.
6. Bell housing bolts.
7. Engine mounting through-bolts.
8. Block heater wire.
9. Wiring harness, transmission cooler lines, and front battery cable clamp at the oil pan.
10. Fuel return lines at the engine.

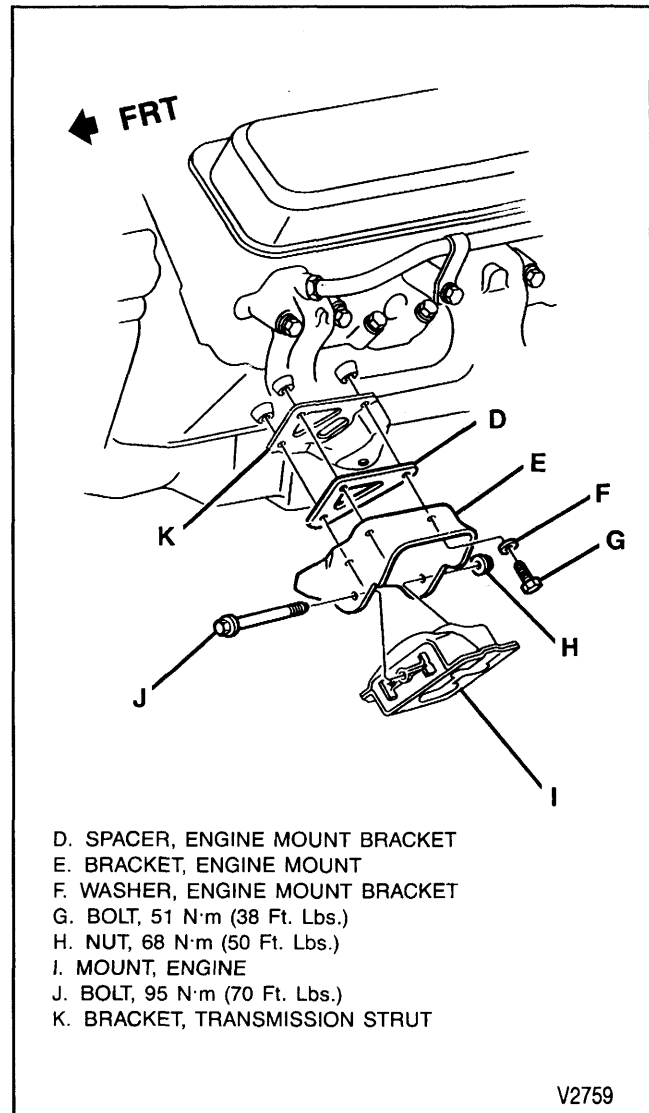


Figure 37—Front Engine Mounting Brackets (2WD and 4WD Models)

11. Oil cooler lines at the engine.
- Lower the vehicle.
12. Hood. Refer to SECTION 2B.
- Drain the cooling system.
13. Air cleaner. Cover the mouth of the intake manifold with J 29664.
14. Generator wires and clips.
15. Wiring at the injector pump.
16. Wiring from the rocker arm clips, including the glow plug wires.
17. EGR-EPR solenoids, glow plug controller, and temperature solenoid. Move the harness aside.
18. Left or right side ground strap.
19. Upper fan shroud.
20. Fan.
21. Power steering pump and reservoir and lay aside.
22. Accelerator, detent, and cruise control cables at the injection pump.
23. Heater hose at the engine.
24. Radiator.
- Support the transmission with a jack.
25. Engine.

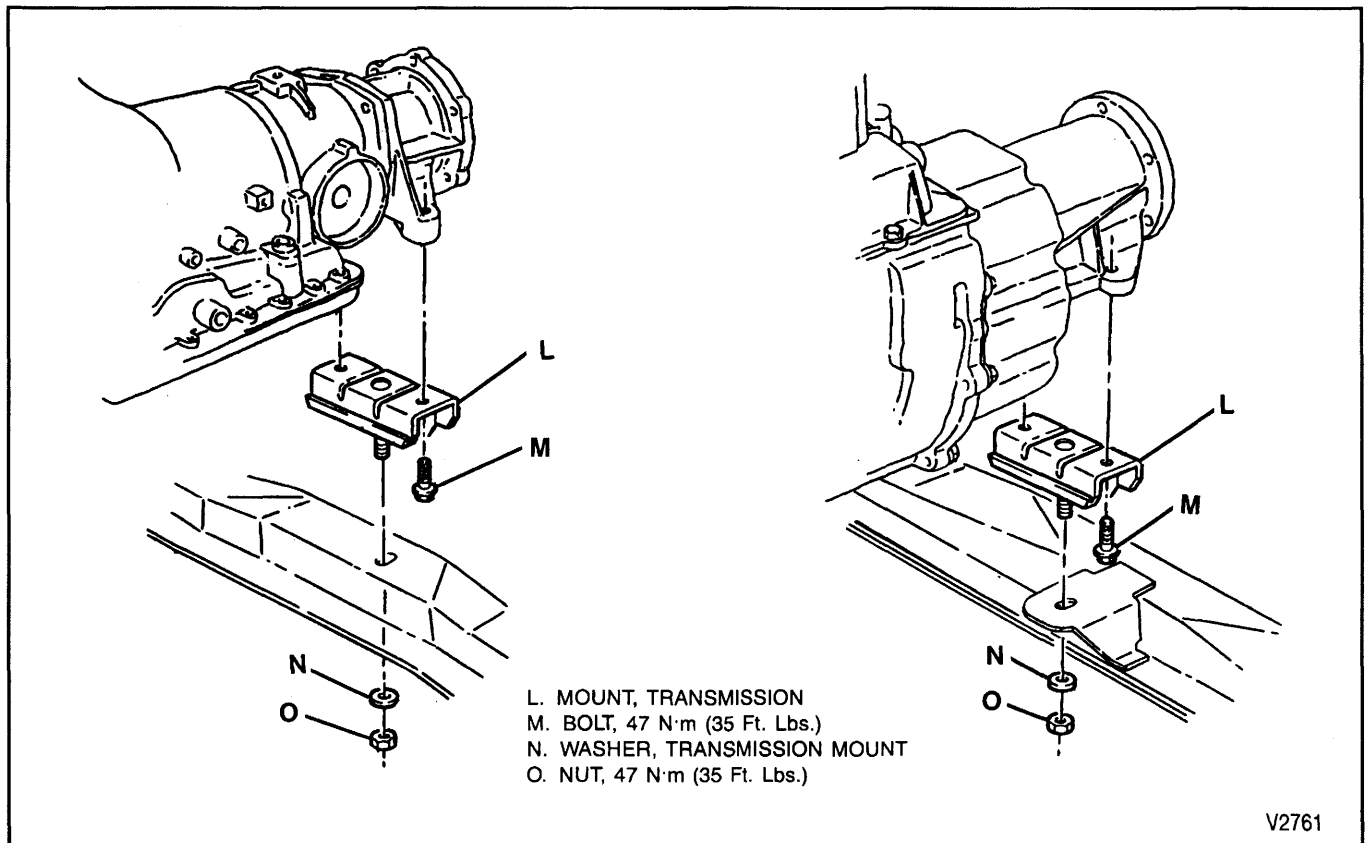


Figure 38—Rear Mounting (2WD Models)

Install or Connect

1. Engine to the vehicle.
2. Radiator.
3. Heater hose.
4. Accelerator, detent, and cruise control cables.
5. Power steering pump and reservoir.
6. Fan.
7. Upper fan shroud.
8. Left or right ground strap.
9. EGR-EPR, glow plug controller, and temperature solenoid.
10. Wiring at the rocker arm clips.
11. Injection pump wires.
12. Generator wires and clips.
13. Air cleaner.
14. Hood. Refer to SECTION 2B.
 - Raise the vehicle and support with safety stands.
15. Fuel return and oil cooler lines at engine.
16. Wiring harness, transmission cooler lines, and front battery cable clamp at the oil pan.
17. Block heater wire.

NOTICE: Refer to "Notice" on page 6A6-1.

18. Engine mounting through-bolts.

Tighten

- Through mount bolt to 95 N·m (70 lbs. ft.) or nut to 70 N·m (52 lbs. ft.).
19. Bell housing bolts.

20. Starter.
21. Exhaust pipes.
22. Flywheel to torque converter bolts (automatic transmission).
23. Flywheel cover.
 - Lower the vehicle.
24. Negative battery cables.
 - Fill the cooling system with the proper quantity and grade of coolant.

FLYWHEEL REPLACEMENT

MANUAL AND AUTOMATIC TRANSMISSIONS

Remove or Disconnect (Figure 40)

1. Transmission, flywheel housing, and clutch (if equipped). Refer to SECTION 7.
2. Flywheel bolts.
3. Flywheel.

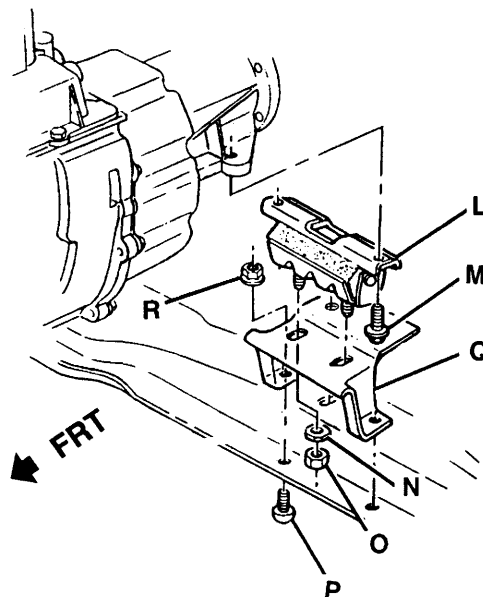
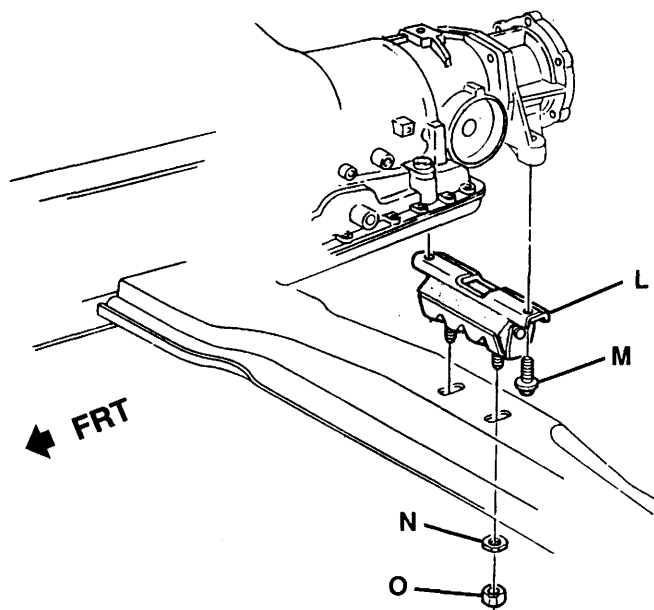
Clean

- Mating surfaces of crankshaft and flywheel. Remove any burrs.

Inspect

- Flywheel for burring, scoring, warping, and wear. Replace the flywheel if necessary. Do not machine the flywheel.
- Flywheel ring gear for worn or broken teeth.

- L. MOUNT, TRANSMISSION
- M. BOLT, 47 N·m (35 Ft. Lbs.)
- N. WASHER, TRANSMISSION MOUNT
- O. NUT, 47 N·m (35 Ft. Lbs.)
- P. BOLT, TRANSMISSION MOUNT BRACKET
- Q. BRACKET, TRANSMISSION MOUNT
- R. NUT, 35 N·m (26 Ft. Lbs.)



V2762

Figure 39—Rear Mounting (2WD with 15,000 GVW and 4WD Models)

FLYWHEEL RING GEAR REPLACEMENT

1. Use a torch to heat the gear around the entire circumference on the engine side of the gear. Then drive the gear off the flywheel using care not to damage the flywheel. On vehicles equipped with a dual mass flywheel, be sure to keep heat away from the dual mass flywheel springs and plastic spring retainers.

NOTICE: Never heat the ring gear to red hot as this will change the metal hardness.

2. Uniformly heat the flywheel gear to a temperature that will expand the gear to permit installation. Temperature must not exceed 278° C (500° F).
3. As soon as the gear has been heated, install on the flywheel.

Install or Connect (Figure 40)

1. Flywheel.

NOTICE: Refer to "Notice" on page 6A6-1.

2. Flywheel bolts.



Tighten

- Flywheel bolts to 90 N·m (65 lbs. ft.).

3. Transmission, flywheel housing, and clutch (if equipped). Refer to SECTION 7.

DUAL MASS FLYWHEEL REPLACEMENT (MANUAL TRANSMISSION ONLY WITH L65, VIN F)



Remove or Disconnect (Figure 41)

1. Transmission assembly. Refer to SECTION 7B.
2. Clutch and clutch housing. Refer to SECTION 7C.
3. Bolts and washers.
4. Retainer plate.

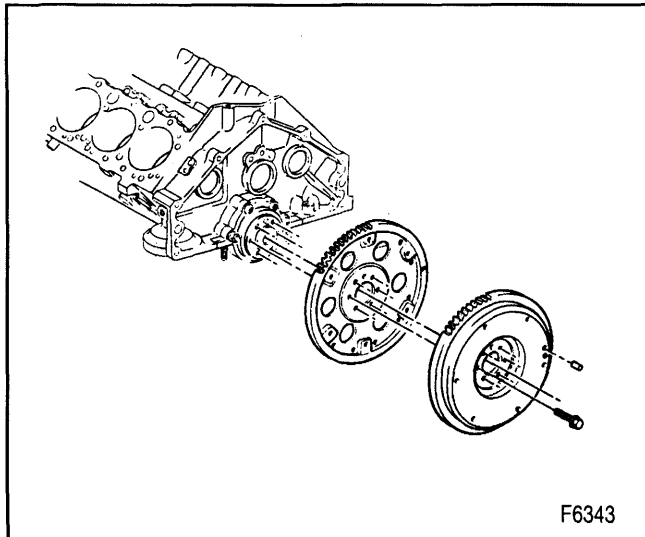


Figure 40—Flywheel

- 5. Flywheel.
- 6. Dowel pin (if equipped).

Install or Connect (Figure 41)

- Position flywheel on crankshaft flange. Then coat the threads of the flywheel attaching bolts with sealant.

- 1. Dowel pin (if equipped).
- 2. Retainer plate.

NOTICE: Refer to "Notice" on page 6A6-1.

- 3. Washers and bolts.

Tighten

- Bolts to 60 N·m (45 lbs. ft.).
 - Position clutch on the flywheel.
- 4. Clutch and clutch housing. Refer to SECTION 7C.
 - 5. Transmission assembly. Refer to SECTION 7B.

DUAL MASS FLYWHEEL REPAIR

Disassemble (Figure 42)

- Remove the transmission. Refer to SECTION 7B.
- 1. Attaching bolts that hold the secondary flywheel to the primary flywheel assembly.

NOTICE: Use care to ensure that the secondary flywheel does not fall off the vehicle.

- 2. Using a screwdriver or similar object, pry around the outer edge of the secondary flywheel to remove it from the mounting pilot.

Inspect

- Flywheel for cracks or heat checks.
- Flywheel for scored or worn surfaces.
- Ring gear for worn, chipped, or cracked teeth. Replace ring gear if any teeth are damaged.

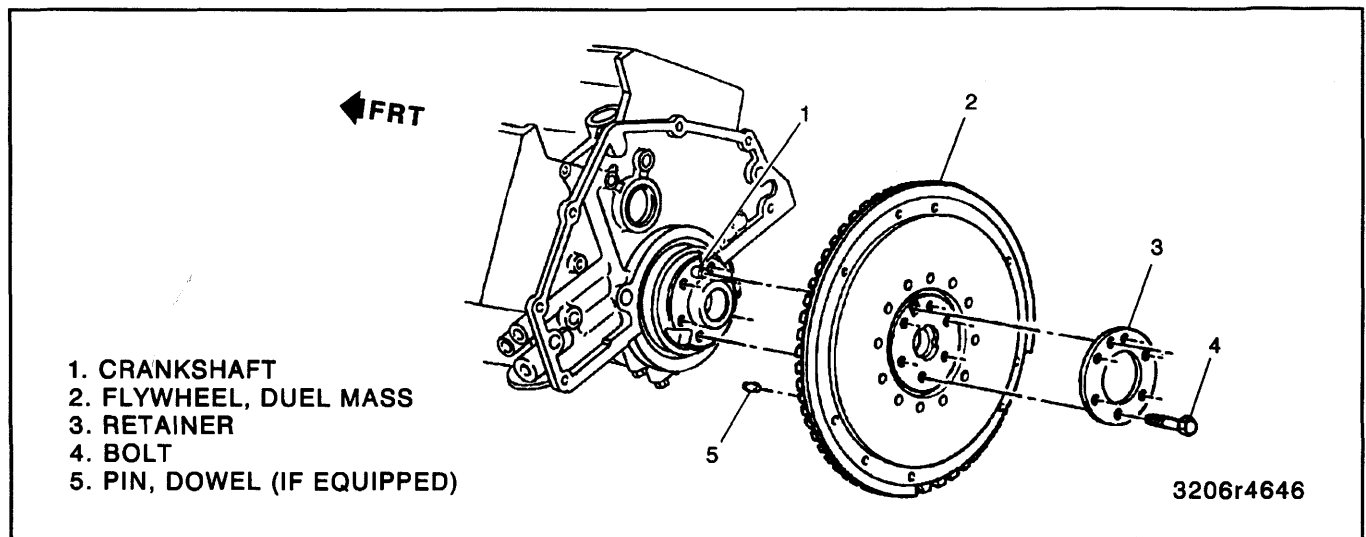
Measure

- The thickness of the secondary flywheel. Replace the secondary flywheel if the thickness is below 1.016 mm (0.040 inch).

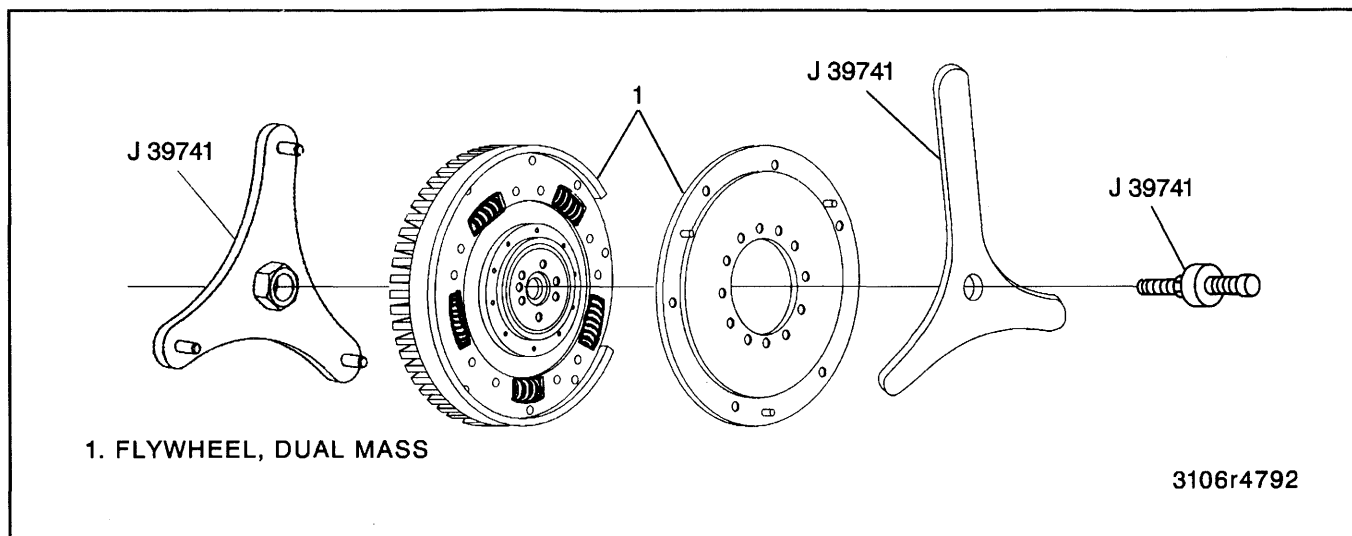
NOTICE: The 5.5-mm (0.217-inch) step on the secondary flywheel must be maintained to ensure proper attachment and function of the clutch assembly. If 1.0 mm (0.0394 inch) is removed from the friction surface, 1.0 mm (0.0394 inch) must be removed from the secondary flywheel mounting surface.

Clean

- Clutch friction surface with a suitable commercial alcohol base solvent. Be sure that the surfaces are free from any oil film.



Figure—41 Dual Mass Flywheel



Figure—42 Dual Mass Flywheel Assembly



Assemble (Figure 42)

Tool Required:

J 39741 Dual Mass Flywheel Assembly Fixture

- Position secondary flywheel onto its mounting pilot on the primary flywheel assembly.

1. Align the secondary flywheel attaching bolt holes with threaded holes in the hub.
2. Compress primary and secondary flywheel assembly using J 39741 (figure 42).

3. New secondary flywheel attaching bolts that contain thread lock (3M Scotch grip) and install bolts.



Tighten

- Bolts to 17 N.m (12 lbs. ft.) alternating across from each other.
4. Clutch pressure plate and friction disc.
 5. Clutch assembly to transmission. Refer to SECTION 7B.

THREAD REPAIR

Damaged threads may be reconditioned by drilling out, rethreading, and installing a suitable thread insert.

Tools Required:

General purpose thread repair kits are available commercially.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch, and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to required depth.



Important

- Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.
2. Drill out damaged thread. Clean out chips.

3. Tap hole. Lubricate tap with light engine oil. Clean the thread.



Important

- Avoid build-up of chips. Back out the tap every few turns and remove chips.
4. Thread the thread insert onto the mandrel of the installer (figure 43). Engage the tang of the insert onto the end of the mandrel.
 5. Lubricate the insert with light engine oil (except when installing in aluminum) and install.



Important

- When correctly installed, the insert should be flush to one turn below the surface.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

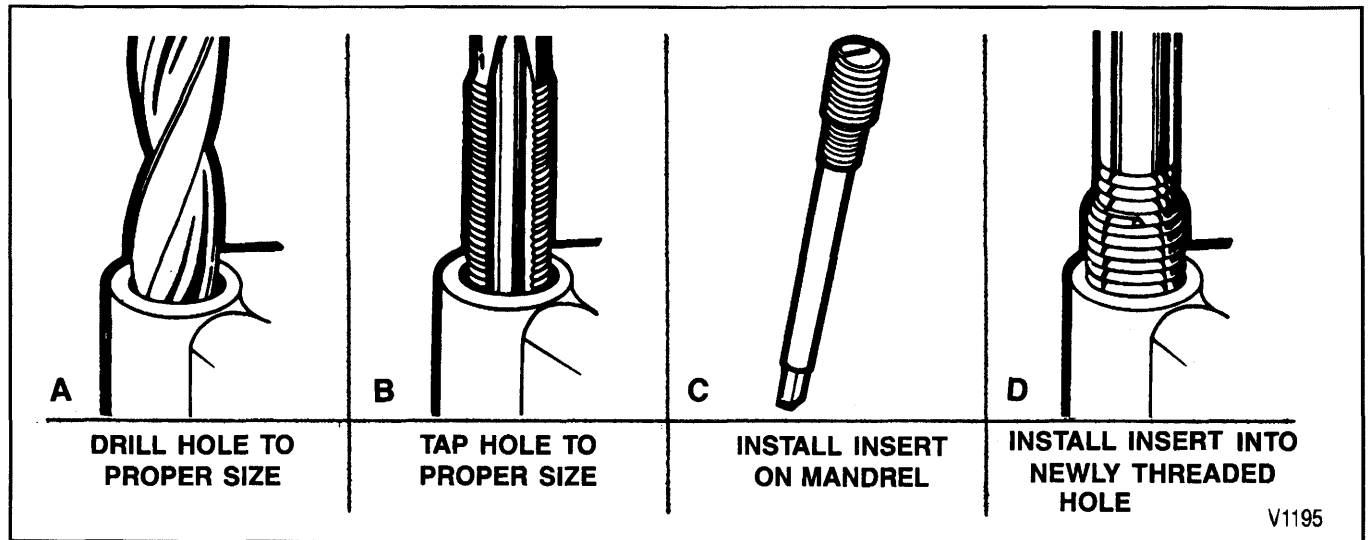


Figure 43—Repairing Thread Holes

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Item	N-m	Lbs. Ft.	Lbs. In.
Bell Housing Bolts.....	40	30	—
Block Drain Plugs.....	22	16	—
Camshaft Gear Bolt	171	126	—
Camshaft Thrust Plate	23	17	—
Connecting Rod Cap Nuts.....	65	48	—
Coolant Crossover/Thermostat Housing Bolts	42	31	—
Crankshaft Pulley Bolts.....	40	30	—
Cylinder Head Bolts—Refer to Procedure	—	—	—
Dual Mass Flywheel.....	60	45	—
Exhaust Manifold Bolts	35	26	—
Flywheel Bolts	90	66	—
Front Cover to Block Bolts	45	33	—
Glow Plugs	14	—	124
Hydraulic Lifter Guide Plate Clamp Bolts	26	19	—
Intake Manifold Bolts.....	42	31	—
Injection Lines	25	19	—
Injection Nozzles	70	50	—
Injection Pump Gear Bolts.....	23	17	—
Injection Pump Nuts.....	42	31	—
Oil Filter Adapter Bolt	65	47	—
Main Bearing Cap Bolts—Inner.....	150	111	—
Outer	135	100	—
Oil Pan Bolts (all except rear two bolts).....	10	—	89
(rear two bolts).....	23	17	—
Oil Pump Bolt.....	90	66	—
Oil Pan Drain Plug.....	27	20	—
Oil Pump Cover Screws	16	12	—
Oil Pump Drive Clamp Bolt.....	42	31	—
Rocker Arm Cover Bolts.....	22	16	—
Rocker Arm Shaft Bolts.....	55	41	—
Secondary Flywheel Bolt	17	12	—
Torsional Damper Bolt.....	270	200	—
Turbocharger to Exhaust Manifold Nuts.....	50	37	—

DUAL MASS FLYWHEEL SPECIFICATIONS

Flywheel and Ring Gear Runout.....	0.76 mm (0.030 inch)
Flywheel and Ring Gear Concentricity.....	0.50 mm (0.020 inch)
Flywheel Friction Surface Maximum Stock Removal During Refacing.....	1.016 mm (0.040 inch)

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ENGINE SPECIFICATIONS

All Specifications are in millimeters (mm) unless otherwise noted.

GENERAL DATA:			
Displacement		6.5L	
RPO		L49, L56, and L65	
Type		90-degree V8 Diesel	
Bore		103	
Stroke		97	
Compression Ratio		21.3:1	
Firing Order		1-8-7-2-6-5-4-3	
Oil Pressure		10 psi at idle (hot); 40-45 psi at 2000 RPM	
CYLINDER BORE: ¹			
Diameter		Refer to "Service Piston and Bore Specifications"	
Out Of Round		0.02 (Maximum)	
Taper (Thrust Side)		0.02 (Maximum)	
PISTON DIAMETER:		Refer to "Service Piston and Bore Specifications"	
Piston to Bore Clearance	Bohn Pistons	Bores 1 through 6	.094-0.120
		Bores 7 and 8	0.107-0.133
PISTON RING:			
Compression	Groove Clearance	Top	Keystone Type Ring
		2nd	0.039-0.079
	Gap ²	Top	0.26-0.51
		2nd	0.75-1.00
Oil	Groove Clearance		0.040-0.090
	Gap		0.25-0.51
PISTON PIN:			
Diameter		30.9961-31.0039	
Clearance (Piston Pin to Piston Bore)		0.0101-0.0153	
Fit in Rod (Piston Pin to Rod Pin Bushing)		0.0081-0.0309	
CRANKSHAFT:			
Main Journal	Diameter	#1, #2, #3, #4	Refer to "Crankshaft Main Bearing Selection" Specifications
		#5	
	Taper		0.005 (Maximum)
	Out of Round		0.005 (Maximum)
Main Bearing Clearance		#1, #2, #3, #4	0.045-0.083
		#5	0.055-0.093
Crankshaft End Play		0.10-0.25	
Crankpin	Diameter		60.913-60.939
	Taper		0.005 (Maximum)
	Out-of-Round		0.005 (Maximum)
Rod Bearing Clearance (Select Fit)		0.045-0.100	
Rod Side Clearance		0.17-0.63	

¹NOTE: Add 0.013mm to cylinder bore diameters to determine proper bore size for cylinders #7 and #8.

²NOTE: Ring end gap specifications are for new bores, worn bores will generate larger ring end gaps.

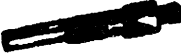
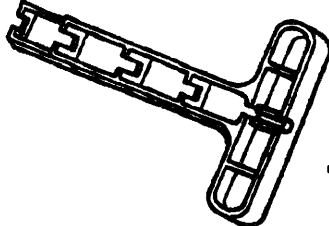
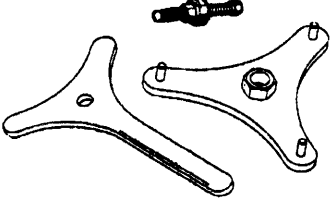
ENGINE SPECIFICATIONS (CONT.)

All Specifications are in millimeters (mm) unless otherwise noted.

DISPLACEMENT		6.5L
CAMSHAFT:		
Lobe Lift $\pm$ 0.05	Intake	7.133
	Exhaust	7.133
Journal Diameter	#1, #2, #3, #4	54.970-55.025
	#5	50.970-51.025
Journal Clearance #1, #2, #3, #4		0.025-0.118
Journal Clearance #5		0.020-0.113
Camshaft End Play		0.051-0.305
VALVE SYSTEM:		
Lifter		Hydraulic Roller
Rocker Arm Ratio		1.5:1
Valve Lash	Intake	Not Adjustable
	Exhaust	
Valve Protrusion (Negative because valve is recessed in head)	Intake	-.034
	Exhaust	-.048
Face Angle (Intake & Exhaust)		45°
Seat Angle (Intake & Exhaust)		46°
Seat Runout (Intake & Exhaust)		0.05
Seat Width	Intake	0.89-1.53
	Exhaust	1.57-2.36
Stem Clearance	Intake	0.026-0.069
	Exhaust	0.026-0.069
Valve Spring	Pressure Newtons @ mm	Closed 356 N @ 46.0 mm
		Open 1025 N @ 35.3 mm
	Installed Height	46
Timing Chain Free Play	New Chain	12.7 mm (0.500-inch)
	Used Chain	20.3 mm (0.800-inch)

T2843

SPECIAL TOOLS

- | | | | | | |
|----|---|------------|-----|---|---------|
| 1. |  | J 8037 | 8. |  | J 29664 |
| 2. |  | J 38606 | 9. |  | J 8080 |
| 3. |  | J 26999-10 | 10. |  | J 39083 |
| 4. |  | J 26999-30 | 11. |  | J 39084 |
| 5. |  | J 29834 | 12. |  | J 26999 |
| 6. |  | J 22102 | 13. |  | J 39741 |
| 7. |  | J 39046 | | | |

1. RING COMPRESSOR
2. VALVE SPRING COMPRESSOR
3. AIR LINE ADAPTER
4. AIR LINE ADAPTER
5. HYDRAULIC LIFTER REMOVER
6. SEAL INSTALLER
7. TORSIONAL DAMPER REMOVER
8. MANIFOLD COVER SET
9. MAIN BEARING REPLACER
10. GLOW PLUG CONNECTOR REMOVER AND INSTALLER
11. REAR CRANKSHAFT SEAL INSTALLER
12. COMPRESSION GAGE
13. DUAL MASS FLYWHEEL ASSEMBLY FIXTURE

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NOTES

SECTION 6B1

ENGINE COOLING

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION**COOLING SYSTEM**

All C/K-Model vehicles have pressure-type engine cooling systems with thermostatic control of the coolant circulation. The cooling system is sealed by a pressure-type cap that allows the system to operate at higher than atmospheric pressure. The high pressure operation raises the boiling point of the coolant, which increases the cooling efficiency of the radiator. The 105 kPa (15 psi) pressure cap raises the boiling point of the coolant to about 125°C (257°F) at sea level.

The radiator cap has an integral pressure-vacuum valve. This valve releases the expanding coolant when it reaches approximately 105 kPa (15 psi) and routes it to the coolant recovery reservoir. The vent function allows the coolant to return to the radiator. As the system cools, the extra coolant in the reservoir is drawn into the radiator through the vent valve. The nominal 105 kPa (15 psi) pressure will not be reached until the system is working at maximum capacity. Any air or vapor in the cooling system will be forced to the coolant reservoir and out through the vent tube at the top of the reservoir. In this manner, the radiator keeps itself full at all times.

COOLANT RECOVERY TANK

Gasoline engines use a plastic reservoir, connected to the radiator by a hose. As the vehicle is driven, the coolant is heated and expands. The portion of the fluid displaced by this expansion flows from the radiator into the recovery bottle. When the vehicle is stopped and the coolant cools and contracts, vacuum draws the displaced coolant back into the radiator. This keeps the radiator full at all times, resulting in maximum cooling efficiency.

Keep the coolant level between the "HOT" and "COLD" marks on the recovery bottle. These marks are about one liter (one quart) apart. Use a 50/50 mixture of ethylene glycol anti-freeze and soft or distilled water.

DIESEL SURGE TANK

The diesel engine uses a cooling system with a surge tank. The pressure cap for the diesel engine is different than the gasoline engine pressure cap and is located on the surge tank. The surge tank used with the diesel engine cooling system is pressurized. Coolant circulates through the surge tank to allow any air that is in the system to be removed and to provide room for the coolant to expand when the coolant is hot.

COOLANT PUMP

The die-cast pump is of the centrifugal vane impeller type. The impeller turns on a steel shaft that rotates in a permanently lubricated ball bearing.

The pump inlet is connected to the bottom of the radiator by a rubber hose. From the pump, coolant passes through the engine front cover into the coolant passages in the block to pick up excess engine heat.

THERMOSTAT

A pellet-type thermostat in the coolant outlet passage controls the flow of engine coolant to provide fast engine warm-up and regulate coolant temperatures. A wax pellet element in the thermostat expands when heated and contracts when cooled. The pellet is connected through a piston to a valve. When the pellet is heated, pressure is exerted against a rubber diaphragm to force the valve open. As the pellet cools, the contraction allows a spring to close the valve. This allows the valve to remain closed while the coolant is cold, preventing circulation of coolant through the radiator. At

this point, coolant circulates throughout the engine to warm the engine quickly and evenly.

As the engine warms, the pellet expands and the thermostat valve opens. The coolant then flows through

the radiator where heat is passed through the radiator walls. This opening and closing of the thermostat allows the cooling system to keep the engine in the correct operating temperature range.

DIAGNOSIS OF ENGINE COOLING

SYSTEM CHECKS

DRIVE BELT - MULTIPLE RIBBED BELT

Check the drive belt for looseness, damage, or fabric delamination. If the belt is loose, check the belt tensioner for proper operation. The belt tensioner is not adjustable. If it is not working properly, it must be replaced. If the belt is delaminated or damaged, replace it.



Important

- Cracks across the rib material are a normal part of the belt aging process. Cracks do not affect belt operation, and do not indicate a need to replace it.

Check the belt length scale on the tensioner. If it reads outside the "acceptable" range, check for proper routing as shown on the belt routing label and in this section. Also check for proper tracking of belt ribs in the pulley grooves, correct pulley sizes (including idlers), and correct belt length.



Important

- Multiple rib belts stretch and wear very little. Normal stretch and wear rarely exceeds 10 mm (3/8 inch) on the belt length scale.

EXHAUST LEAKS

To check for exhaust leaking into the cooling system, drain the system until the coolant level stands just above the top of the cylinder heads, then disconnect the upper radiator hose and remove the thermostat and belt. Start the engine and accelerate several times. At the same time, note any appreciable coolant rise or the appearance of bubbles that may indicate that exhaust gases are leaking into the cooling system.

NOTICE: *A worn head gasket may allow exhaust gases to leak into the cooling system. This can damage the cooling system as the gases combine with the water to form acids that are harmful to the radiator and engine.*

COOLANT PUMP

Check coolant pump operation by running the engine while squeezing the upper radiator hose. When the engine warms, a pressure surge should be felt. Check for a plugged vent hole in the pump.

RADIATOR

Test for restrictions in the radiator by warming the engine up, turning the engine off, and feeling the radiator. The radiator should be hot along the left side and warm along the right side, with an even temperature rise from right to left. Cold spots in the radiator indicate clogged sections.

THERMOSTAT

Make an operational check of the thermostat by hanging the thermostat on a hook in a 33 percent glycol solution, -12°C (10°F) below the temperature indicated on the valve. With the valve submerged and the coolant agitated, the valve should close.

OVERHEAT AND/OR NOISE

Restrictions in the cooling system can cause engine overheating and/or cooling system noise.

Components prone to this condition are the cylinder head, coolant pump, block, thermostat housing, and inlet manifold. Symptoms are:

- Engine may make snapping/cracking noises.
- Heater core may gurgle or surge.
- Radiator hoses may collapse and expand.
- Heater hoses may vibrate and thump.
- Overheat light may or may not come on.

Symptoms are caused by coolant boiling at some localized area and may be noticed after extended idling and/or while driving. Determine which side of the engine is involved and whether it is at the front or rear of the engine.

Diagnosis/Inspection

1. Isolate the area by probing the engine with a sounding bar (large screwdriver).

CAUTION: The radiator or diesel surge tank cap should be removed from a cool engine only. If the radiator cap is removed from a hot cooling system, serious personal injury may result.

2. With the radiator cap removed, observe the coolant being circulated in the radiator. Feel the front area of the radiator for cold spots which indicate blockage. Blocked radiators generally occur on units that have accrued miles and not on new vehicles.
3. Inspect the thermostat to see if it opens.
4. Inspect the thermostat housing to make sure it is free of obstructions.
5. Remove the coolant pump from the vehicle and remove the back cover on the pump. Inspect all internal passages using a flashlight.
6. Inspect the crossover at the front of the inlet manifold. This entire passage can be seen only with the thermostat removed.
7. Remove the heads and check the block with a pen light flashlight. Never replace a block unless the restricted area can be seen.
8. Inspect the heads if the problem is not found. Heads with blocked coolant passages generally have more than one area that is blocked. Look for signs of overheat discoloration (a dark blue or black area). If none are found, look in the coolant passages for blockage and probe all accessible

6B1-4 ENGINE COOLING

passages. The head is intricate, and all the passages cannot be reached. Use a substantial wire to go through or around a partially blocked area. If nothing is found by visual inspection and probing, inspect the passages for a rough, ragged appearance. The roughest internal passages are probably the ones that are blocked. Replace a blocked or suspect head and inspect the replacement head before installation.

FAN CLUTCH DIAGNOSIS

NOISE

Fan noise is sometimes evident under the following normal conditions.

- When the clutch is engaged for maximum cooling.
- During the first 15 seconds to one minute after start-up until the clutch can re-distribute the silicone fluid back to its normal disengaged operating condition (after overnight settling).

Fan noise or an excessive roar will generally occur continuously under all high engine speed conditions (2500 rpm and up) if the clutch assembly is locked up due to an internal failure. If the fan cannot be rotated by hand or there is a rough grating feel as the fan is turned, replace the clutch. Refer to "Fan and Fan Clutch Replacement."

LOOSENESS

Check a loose fan assembly for wear and replace as necessary. Under various temperature conditions, there is a visible lateral movement at the tip of the fan blade. Approximately 6.5 mm (1/4 inch) maximum lateral movement measured at the fan tip is allowable. This is not cause for replacement.

SILICONE FLUID LEAKS

The fan clutch operation is affected by fluid leaks which may occur in the area around the bearing assembly. If leakage appears, replace the fan clutch. Refer to "Fan and Fan Clutch Replacement."

ENGINE OVERHEATING

1. Start with a cool engine to ensure complete fan clutch disengagement.
2. If the fan and clutch assembly free-wheels with no drag (revolves more than five times when spun by hand), replace the clutch. Refer to "Fan and Fan Clutch Replacement." If the clutch performs properly with a slight drag, go to step C.
 - Testing a fan clutch by holding the small hub with one hand and rotating the aluminum housing in a clockwise/counterclockwise motion will cause the clutch to free-wheel, which is a normal condition when operated in this manner. This should not be considered a test by which replacement is determined.
3. Position a thermometer so it is located between the fan blades and the radiator. This can be achieved by inserting the thermometer sensor through one of the existing holes in the fan shroud or by placing it between the radiator and the shroud. On some models, it may be necessary to drill a 5-mm

(3/16-inch) hole in the fan shroud to insert the thermometer.

NOTICE: Check for adequate clearance between fan blades and the thermometer sensor before starting engine, as damage could occur.

4. With the thermometer in position, cover the radiator grille sufficiently to induce a high engine temperature, start the engine, turn air conditioning on, and operate at 2000 rpm.
5. Observe thermometer reading when the clutch engages. It will take approximately 5 to 10 minutes for the temperature to become high enough to allow engagement of the fan clutch on gasoline engines and 15 to 20 minutes on diesel engines. This will be indicated by an increase or roar in fan air noise and by a drop in the thermometer reading of approximately 3°C to 10°C (5°F to 15°F).
 - If the clutch did not engage between 65°C to 96°C (150°F to 205°F) the unit should be replaced. Be sure the fan clutch was disengaged at the beginning of the test.
 - If no sharp increase in fan noise or temperature drop was observed and the fan noise level was constantly high from start of test to 88°C (190°F), the unit should be replaced. Do not continue the test past a thermometer reading of 96°C (205°F) to prevent engine overheating.
6. As soon as the clutch engages, remove the radiator grille cover and turn the air conditioning off to assist in engine cooling. Run the engine at approximately 1500 rpm.
7. After several minutes, the fan clutch should disengage as indicated by a reduction in fan speed and roar. If the fan clutch fails to function as described, it should be replaced.

THERMOSTAT DIAGNOSIS

Refer to the thermostat diagnostic chart for thermostat diagnosis procedures (figure 1).

COOLANT DIAGNOSIS

HYDROMETER

Due to changes in commercially available antifreeze, the use of a hydrometer may give an incorrect reading. The hydrometer should be used to test ethylene glycol base antifreeze only. Ethylene glycol base antifreeze is recommended for year round use.

COOLANT TESTER

Coolant testers J 26568 (Centigrade Scale) and J 23688 (Fahrenheit Scale) can be used to check the anti-freeze protection of the coolant. Make sure the hydrometer readings are correct. Unless J 26568 or J 23688 has a provision for temperature correction, test the temperature at which J 26568 or J 23688 is calibrated. If the coolant is warmer or cooler, the reading may be incorrect. Follow the manufacturer's directions for using J 26568 or J 23688.

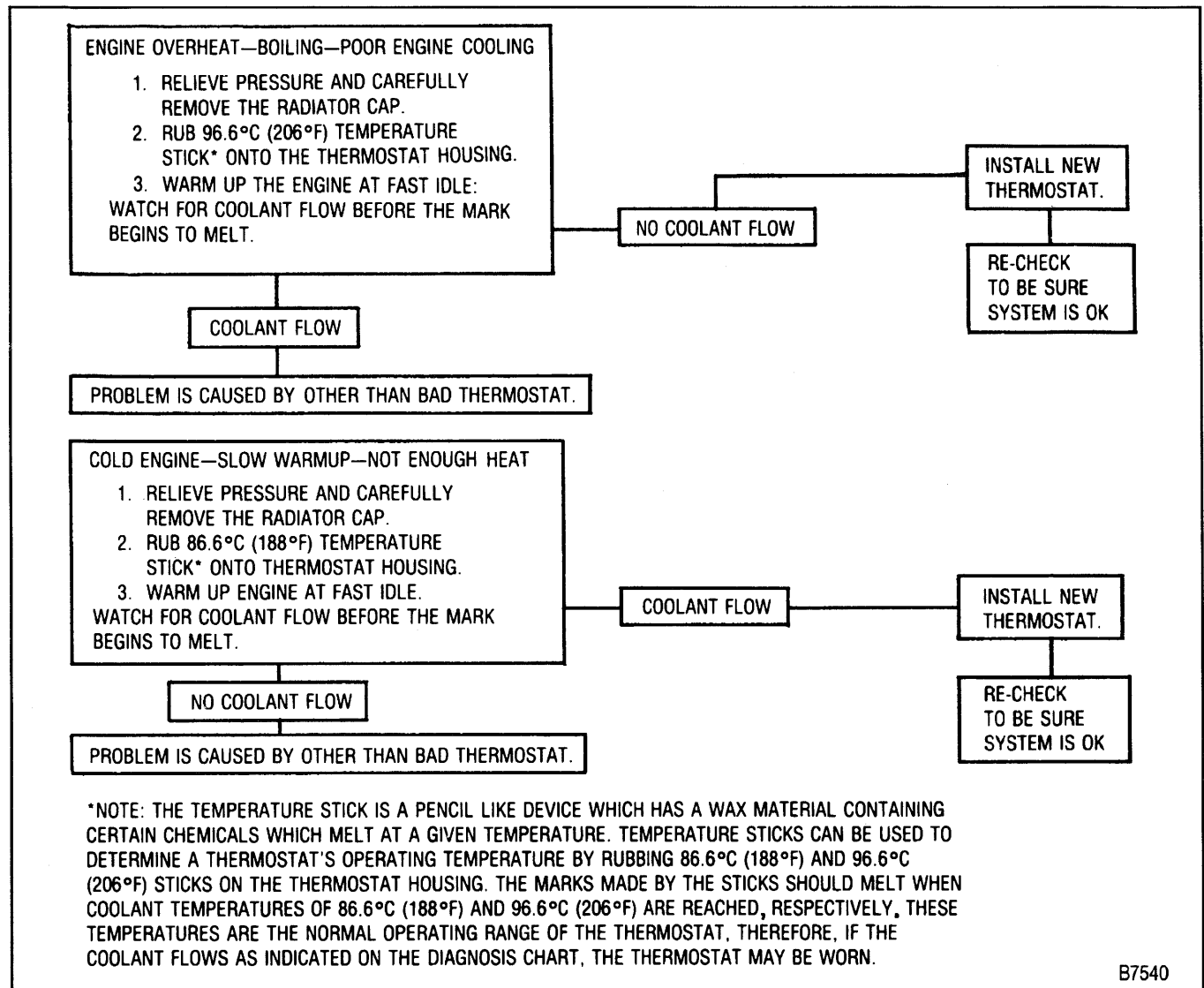


Figure 1—Thermostat Diagnosis Chart

Cleaning

- Before each use, swing the plastic cover back at the slanted end of J 26568 or J 23688, exposing the measuring window and the bottom of the plastic cover (figure 2).
- Wipe dry with tissue or clean soft cloth.
- Close the plastic cover.

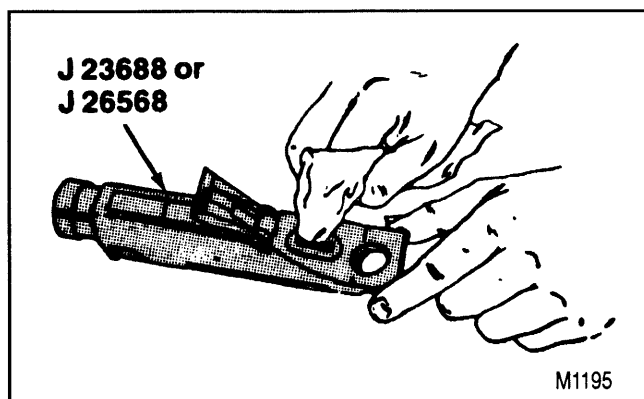


Figure 2—Cleaning the Coolant Tester

Testing

Tools Required:

J 26568 or J 23688 Coolant Tester

- Do not remove the clear plastic pump from the tester.
- 1. Release the tip of the pump from J 26568 or J 23688.
- 2. Insert the tip of the pump into the radiator filler neck (figure 3).
- 3. Make sure the tip of the pump is below the level of the coolant.
- 4. Press and release the bulb to draw a sample.
- 5. Insert the tip of the pump into the cover plate opening.
- 6. Press the bulb and inject a few drops of coolant onto the measuring surface.
- Do not open the plastic cover when taking readings because water evaporation can change the reading.

Reading

- Point J 26568 or J 23688 toward any light source and look into the eyepiece (figure 4).

6B1-6 ENGINE COOLING

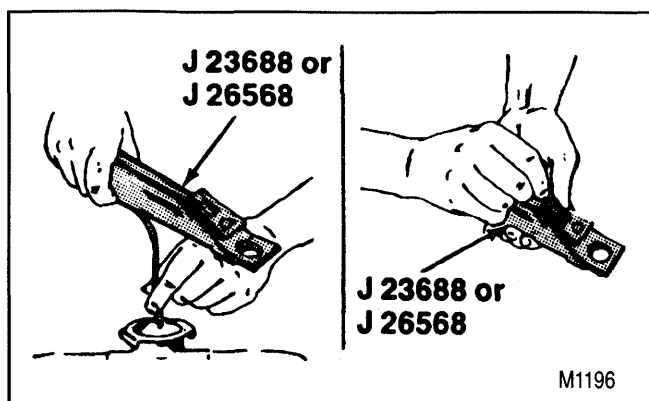


Figure 3—Collecting the Coolant

- Coolant protection reading is at the point where the dividing line between light and dark crosses the scale (antifreeze protection is the scale on the right).
- Temperature scale is reversed from a standard thermometer scale.
- Below zero readings are on upper half of the scale.
- Readings on the lower half of the scale indicate solutions without enough antifreeze concentration to provide adequate rust protection.
- If the readings are not clear, the measuring surfaces were not cleaned and dried properly. Wipe dry and make a new test.

COOLING SYSTEM DIAGNOSIS

Refer to the cooling system diagnosis charts for detailed cooling system diagnostic procedures (figures 5 and 6).

UNCOMMON COOLING SYSTEM PROBLEMS

Problems Not Requiring Disassembly of the Cooling System

1. Remove large obstructions (equipment not approved by GM) blocking the radiator or condenser.

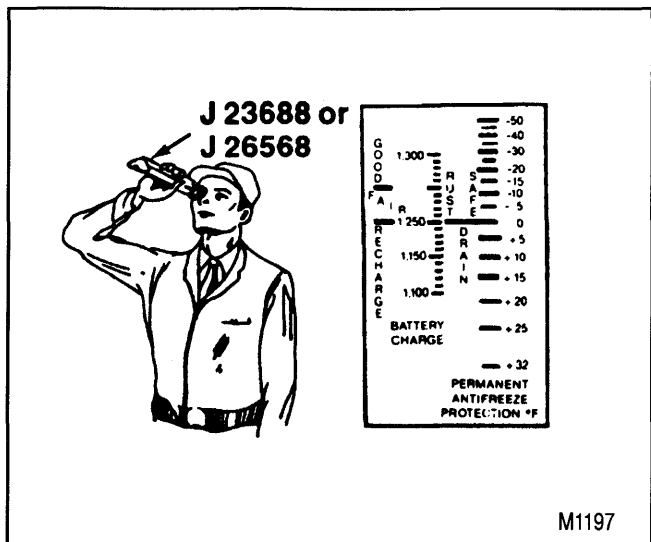


Figure 4—Reading the Coolant Tester

- Auxiliary oil cooler(s).
 - License plates.
 - Spare tires.
 - Ice, mud, or snow obstructing the grille.
 - Fog lamps.
2. Engine oil is overfilled.
 3. Incorrect radiator for the application.
 - Check the part number.
 4. Loose, damaged, or missing air seals.
 5. Missing or damaged lower air baffle.
 6. Incorrect ignition timing.

Problems Requiring Disassembly of the Cooling System

1. Incorrect or damaged fan.
2. Worn or damaged emission system components.
 - Could cause overheating at idle.
 - Damaged positive crankcase ventilation (PCV) valve, thermal vacuum valve (TVV), or engine coolant temperature switch (ECT).
3. Radiator filler neck damage.
 - Shows if the pressure cap leaks because of radiator filler neck damage.
4. Worn or damaged coolant pump.
 - Impeller vanes eroded or broken.
 - Worn or damaged bearing and/or seal. Check for shaft or bearing play.
5. Plugged radiator tubes.
 - Perform a flow check.
6. Internal system leaks.
 - Head gasket.
 - Cracked block.
 - Timing chain cover.
 - Intake manifold gasket.
7. Plugged coolant passages in the cylinder heads.
 - Visual check.

COOLANT LEVEL INDICATOR DIAGNOSIS

DIESEL ENGINES

The coolant level indicator circuit is shown in figure 7.

Indicator Lamp Will Not Illuminate

1. Turn the ignition switch to the "ON" position.
 - If the lamp illuminates, the lamp is OK and the connector is properly installed on the module. Go to step 2.
 - If the lamp does not illuminate, check the bulb, socket, and wiring between the socket and the module connector, as well as the connector on the module. Replace or repair as required.
2. Turn the ignition switch to the "ON" position and disconnect the electrical lead at the coolant level sensor on the radiator.
 - If the lamp fails to illuminate, check the wiring between the coolant level sensor connector and the module for a short circuit to ground. If the circuit is OK, replace the module.

Indicator Lamp Remains Illuminated

1. Turn the ignition switch to the "ON" position.
 - Check the coolant level. Add coolant if necessary.
 - If the lamp remains illuminated, go to step 2.

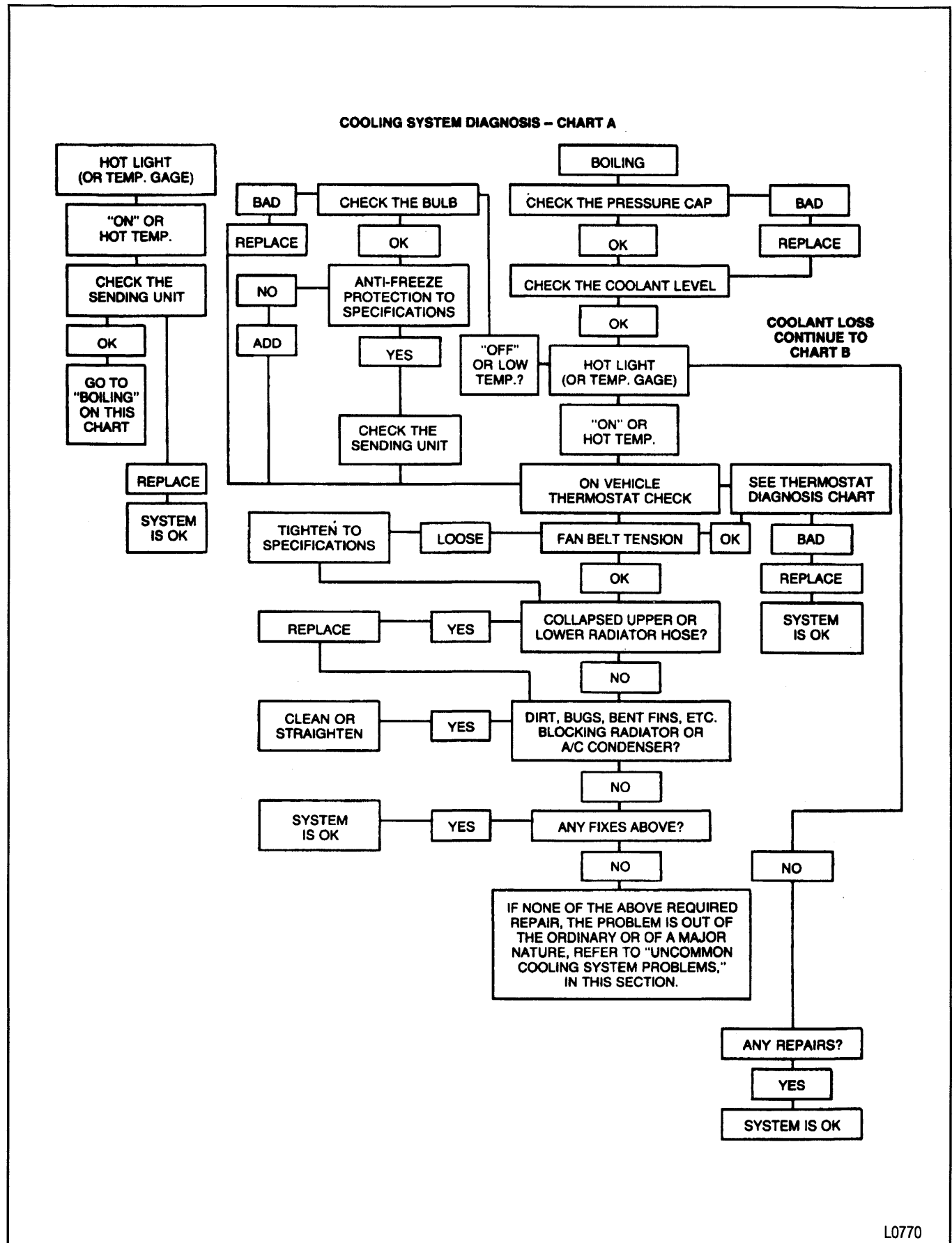
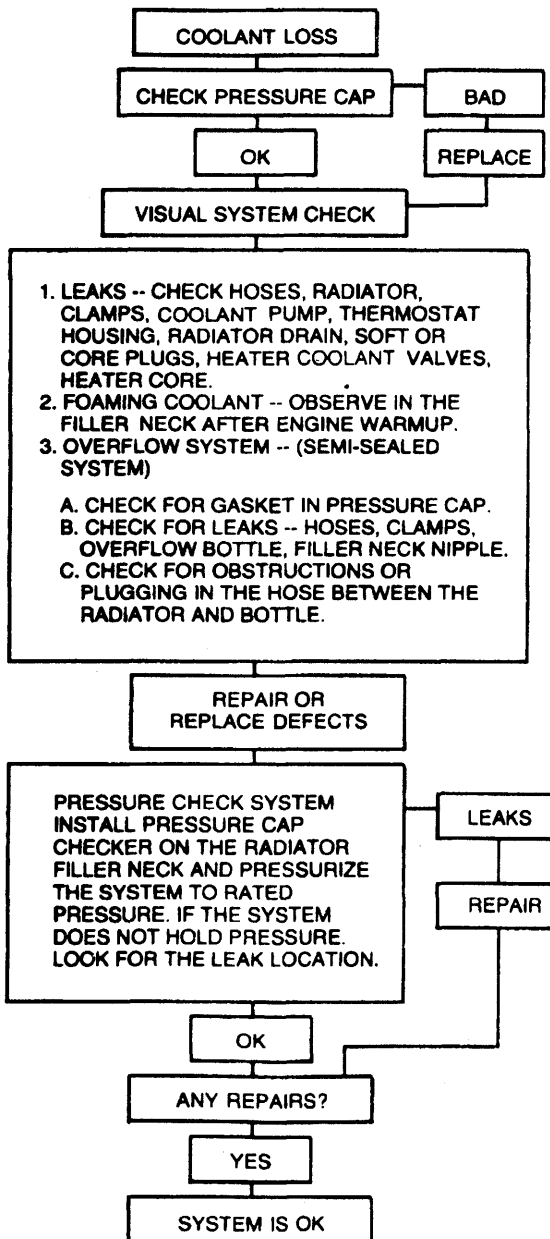


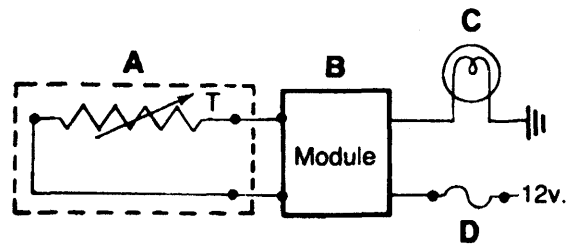
Figure 5—Cooling System Diagnosis Chart

COOLING SYSTEM DIAGNOSIS – CHART B



V0329

Figure 6—Cooling System Diagnosis Chart



- A. Coolant Level Probe
- B. Module
- C. "Low Coolant" Indicator Lamp
- D. Fuse

L0700

Figure 7—Low Coolant Level Sensor Circuit

2. Disconnect the electrical lead at the coolant level sensor on the surge tank and use a jumper wire and "G" type electrical connector.
 - If the lamp does not illuminate, replace the sensor.
 - If the lamp remains illuminated, connect the electrical lead and go to step 3.
3. Check for an open circuit between the sensor and the module.
 - If an open circuit is found, repair it.
 - If no open circuit is found, replace the module.

DIAGNOSIS OF DRIVE BELT SYSTEM

Drive belts and pulleys wear evenly with use. Unusual signs of wear indicate some correction is needed. The following diagnostic chart will aid in diagnosing multiple ribbed belt system problems.

DEFINITIONS:

Chirping: Chirping is a high pitched noise that is usually heard once per revolution of a pulley or belt. It is also usually heard at idle and is most common on cold damp mornings. By squirting water onto a chirping belt, the noise will momentarily go away.

Squeal: Squeal is a loud screeching noise that is usually caused by a slipping belt. The noise usually occurs when a heavy load is applied to the belt, such as compressor engagement, accelerating the engine, or the belt slipping on seized pulley.

Whine: Whine is a high pitched continuous noise that may be caused by a failed bearing.

Faint Cyclic

Rumbling: Faint cyclic rumbling is a deep low frequency noise (once per revolution of the belt).

Pilling: Pilling is the random accumulation of rubber dust in the bottom of the multi-ribbed belt grooves. A small amount of pilling is normal. Operation of the drive belt system will not be affected unless buildup exceeds 1/3 of the belt groove depth.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Chirp	- Misalignment of pulleys. - Power steering pump pulley. - Bent or cracked brackets. - Loose or missing fasteners. - Bent pulley flange. - Severe pilling, exceeding 1/3 of belt groove depth.	- Check pulley alignment. - Refer to SECTION 3B. - Replace as necessary. - Check and re-torque. Replace as necessary. - Replace as necessary. - Replace belt.
Squeal	- Seized bearings. - Insufficient tension. - Incorrect belt length. - Incorrect pulley size. - Malfunctioning tensioner. - Incorrect drive belt routing.	- Replace as necessary. - Replace belt. - Replace pulley. - Replace tensioner. - Refer to drive belt routing.
Whine	Worn bearings.	Replace as necessary.
Faint Cyclic Rumbling	Severe pilling.	Replace belt.
Belt Falls Off	- Misalignment of pulleys. - Bent or cracked brackets. - Loose or missing fasteners. - Misaligned power steering pump pulley. - Damaged belt. - Malfunctioning tensioner. - Worn idler or tensioner pulley bearings.	- Check pulley alignment. - Replace as necessary. - Check and re-torque, replace as necessary. - Refer to SECTION 3B. - Replace as necessary. - Replace as necessary. - Replace as necessary.
Vibration	- Bent or cracked brackets. - Loose or missing fasteners. - Damaged fan blades. - Bent fan clutch or coolant pump shaft.	- Replace as necessary. - Check and re-torque, replace as necessary. - Replace as necessary. - Replace as necessary.
Excessive Wear in Either Outside Groove of Drive Belt	Ribs in the drive belt do not match the grooves in the pulley.	Replace damaged belt as necessary. Refer to Drive Belt Replacement in this section.

ON-VEHICLE SERVICE

DRAINING AND FILLING THE COOLING SYSTEM

Draining

1. Place a drain pan under the radiator drain cock.
2. Install a tube on the drain cock.
3. Place the end of the tube in the pail or pan.
4. Make sure the cooling system is cool, then remove the radiator cap.
5. Open the drain cock completely.
6. Let the cooling system drain until the flow stops.
7. Place a drain pan under the engine.
8. Remove the drain plug in the engine block.
9. Let the engine block drain until the flow stops.
 - There may be more drainage from the radiator at this time.
10. Replace the engine block drain plug.
11. Close the radiator drain cock.

Filling (Gasoline Engines)

1. Check the radiator drain cock to be sure it is closed.
2. Check the engine drain plug to be sure it is tight.
3. Premix the antifreeze with clear water in 50/50 mixture.
 - If the old coolant is being used, check it for glycol/water mix of 50/50.
4. Place a large top funnel in the radiator fill hole.
5. Slowly pour in the coolant. The filling may be slowed because of the thermostat being closed.
6. After the cooling system is filled to 1/2 inch below the fill hole, start the engine and let the cooling system warm up. When the thermostat opens, the coolant level may drop. If the level drops, add coolant until the level is up to the fill hole.
7. Replace the radiator cap.
8. Check the coolant level in the recovery tank. Add coolant if needed.

Filling (Diesel Engines)

1. Open the air bleed valve in the engine coolant outlet (thermostat housing).
2. Fill the surge tank bottle until coolant comes out of the air bleed valve.
3. On vehicles with a rear heater, close the air bleed valve. Start the engine and bring the engine speed to 2000 RPM for 2 to 3 minutes to flush any air for the rear heater. Shut the engine off and open the air bleed valve. Fill the surge tank until coolant comes out the air bleed valve.
4. Close the air bleed valve and install the pressure cap on the surge tank.
5. Monitor the cold coolant level in the surge tank. Add coolant as needed to bring the coolant level to the "Full Cold" mark.

FLUSHING THE COOLING SYSTEM

Various methods and equipment can be used to flush the cooling system. If special equipment such as a back flusher is used, follow the equipment manufacturer's instructions.



Important

- Remove the thermostat before flushing the cooling system.

COOLANT RECOVERY/SURGE TANK REPLACEMENT



Remove or Disconnect (Figures 8 and 9)

1. Coolant from the recovery tank.
2. Clamps.
3. Coolant recovery reservoir hose from the recovery tank.
4. Overflow hose.
5. Bolts.
6. Coolant recovery tank from the vehicle.



Install or Connect (Figures 8 and 9)

1. Coolant recovery tank to the vehicle.

NOTICE: Refer to "Notice" on page 6B1-1.

2. Bolts.



Tighten

- Bolts to 10 N.m (89 lbs. in.).
3. Coolant overflow hose to the recovery tank.
 4. Coolant recovery reservoir hose to the recovery tank.
 5. Clamps.
 6. Coolant in the recovery tank.

RADIATOR HOSE REPLACEMENT

Most C/K-Models use a spring-type clamp at the radiator hose connections. When this type of clamp is used, the radiator hoses should be installed on dry, non-painted surfaces to ensure proper sealing.

4.3L ENGINES



Remove or Disconnect (Figure 10)

- Drain the cooling system.
1. Retaining strap (53) from the upper fan shroud.
 2. Clamps (52 and 56) from the inlet and outlet radiator hoses.
 3. Radiator inlet hose (50).
 4. Radiator outlet hose (51).



Install or Connect (Figure 10)

1. Radiator outlet hose (51).
2. Radiator inlet hose (50).

NOTICE: Refer to "Notice" on page 6B1-1.

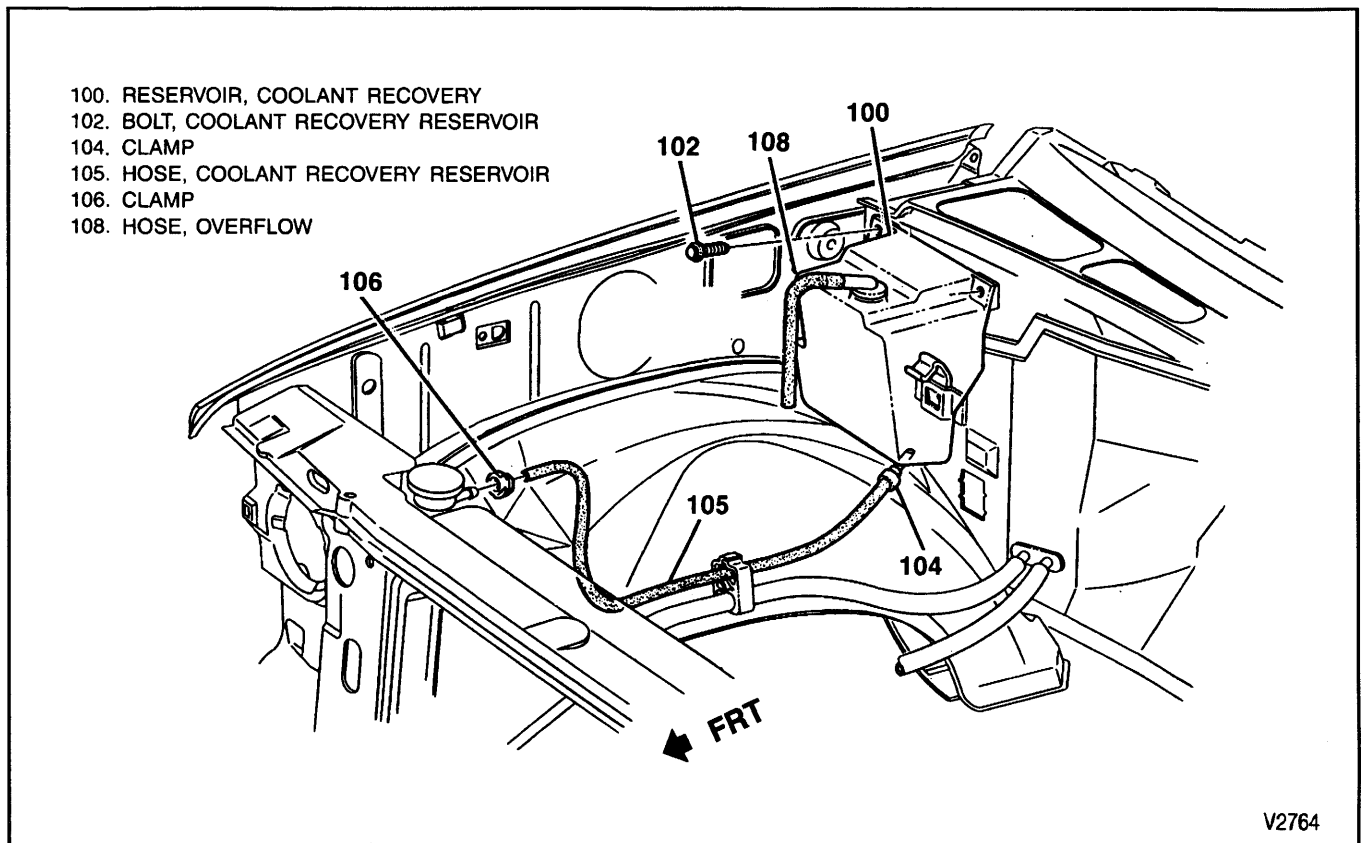


Figure 8—Coolant Recovery System (Gasoline)

3. Clamps (52 and 56) to the inlet and outlet radiator hoses.



Tighten

- Clamps to 3 N·m (27 lbs. in.).

4. Retaining strap (53) to the upper fan shroud.

- Fill the cooling system to the proper level.
- Check for leaks.

5.0L, 5.7L, and 7.4L ENGINES



Remove or Disconnect (Figure 11)

- Drain the cooling system.
1. Retaining strap (53) from the upper fan shroud.
 2. Bolt (59) from the hose support (58).
 3. Hose support (58).
 4. Hose clamps (52 and 56) from the inlet and outlet hoses.
 5. Radiator inlet hose (50).
 6. Radiator outlet hose (51).



Install or Connect (Figure 11)

NOTICE: For steps 3 and 5, refer to "Notice" on page 6B1-1.

1. Radiator outlet hose (51).
2. Radiator inlet hose (50).

3. Clamps (52 and 56) to the radiator inlet and outlet hoses (50 and 51).



Tighten

- Clamps to 3 N·m (27 lbs. in.).

4. Hose support (59) to inlet hose (50).
5. Bolt (58).



Tighten

- Bolt to 3 N·m (27 lbs. in.).

6. Retaining strap (57) to the upper fan shroud.
- Fill the cooling system to the proper level.
 - Check for leaks.

DIESEL ENGINES



Remove or Disconnect (Figure 12)

- Drain the cooling system.
1. Bolts (59) from the inlet hose support (58).
 2. Support (58).
 3. Strap (57) from the outlet hose (51).
 4. Clamps (52 and 56).
 5. Radiator inlet hose (50).
 6. Radiator outlet hose (51).



Install or Connect (Figure 12)

NOTICE: For steps 3 and 7, refer to "Notice" on page 6B1-1.

1. Radiator outlet hose (51).
2. Radiator inlet hose (50).

6B1-12 ENGINE COOLING

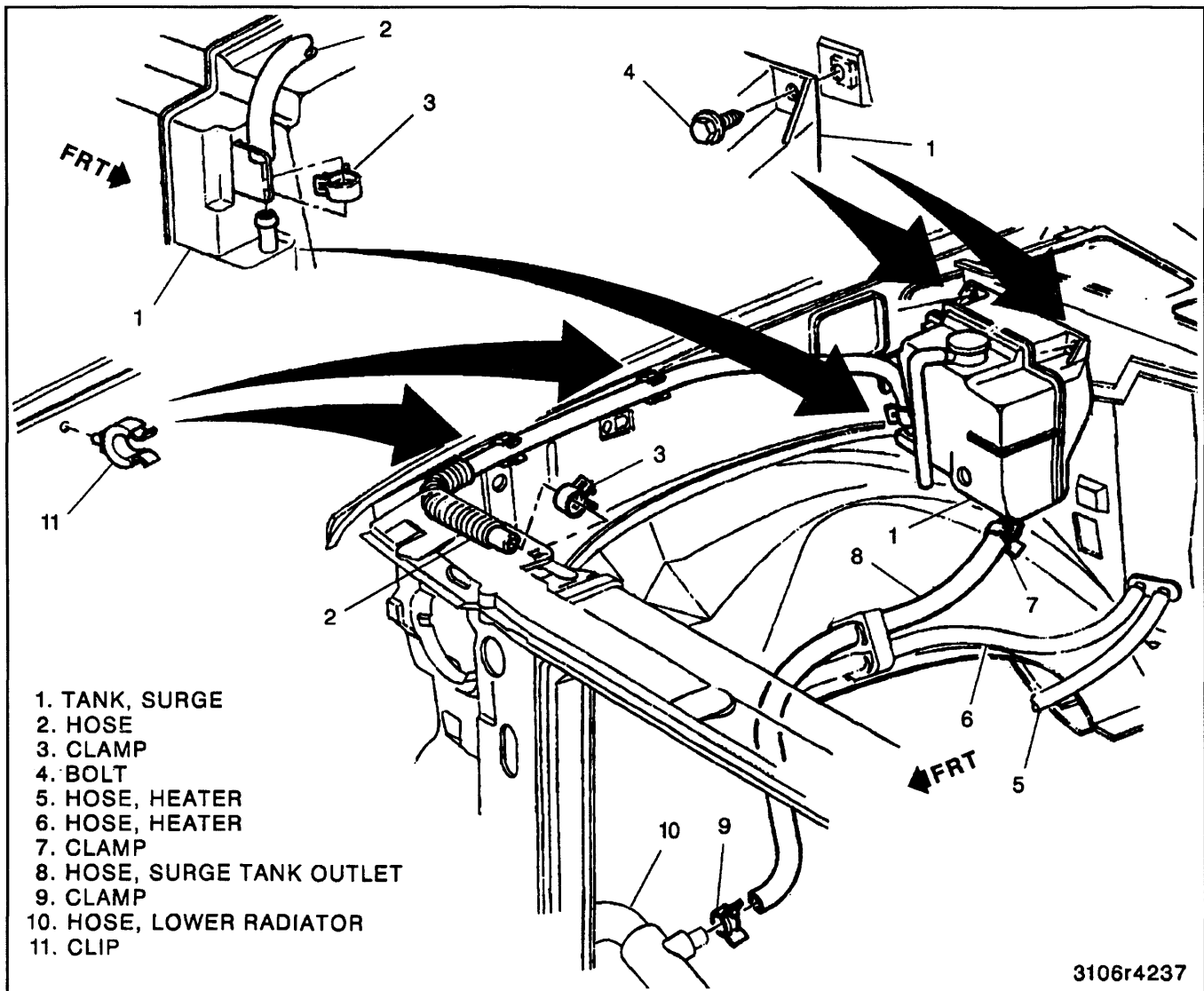


Figure 9—Coolant Surge Tank (Diesel)

3. Clamps (52 and 56).



Tighten

- Clamps to 3 N.m (27 lbs. in.).
4. Strap (57) to the lower fan shroud.
5. Support (58) to the inlet hose (50).
6. Support (58).
7. Bolt (59).



Tighten

- Bolt to 9 N.m (80 lbs. in.).
- Fill the cooling system to the proper level.
- Check for leaks.

FAN AND FAN CLUTCH REPLACEMENT



Remove or Disconnect (Figures 13 and 14)

1. Radiator fan shroud. Refer to SECTION 6B2.
- Locate the yellow dot on the fan clutch hub and mark the coolant pump pulley.

2. Nuts (17).

3. Fan (15) and fan clutch (16) from the coolant pump pulley.

4. Bolts (14).

5. Fan (15) from the fan clutch (16).



Inspect

- Inspect the mating surfaces (the coolant pump hub and the fan clutch hub) for smoothness. Rework as necessary to eliminate any burrs or other imperfections.



Install or Connect (Figures 13 and 14)

CAUTION: Do not repair and reuse a fan with a bent or damaged blade. Replace the fan as an assembly. A damaged blade can change the balance of a fan. A fan out of balance could fly apart during use and cause personal injury or damage to the vehicle.

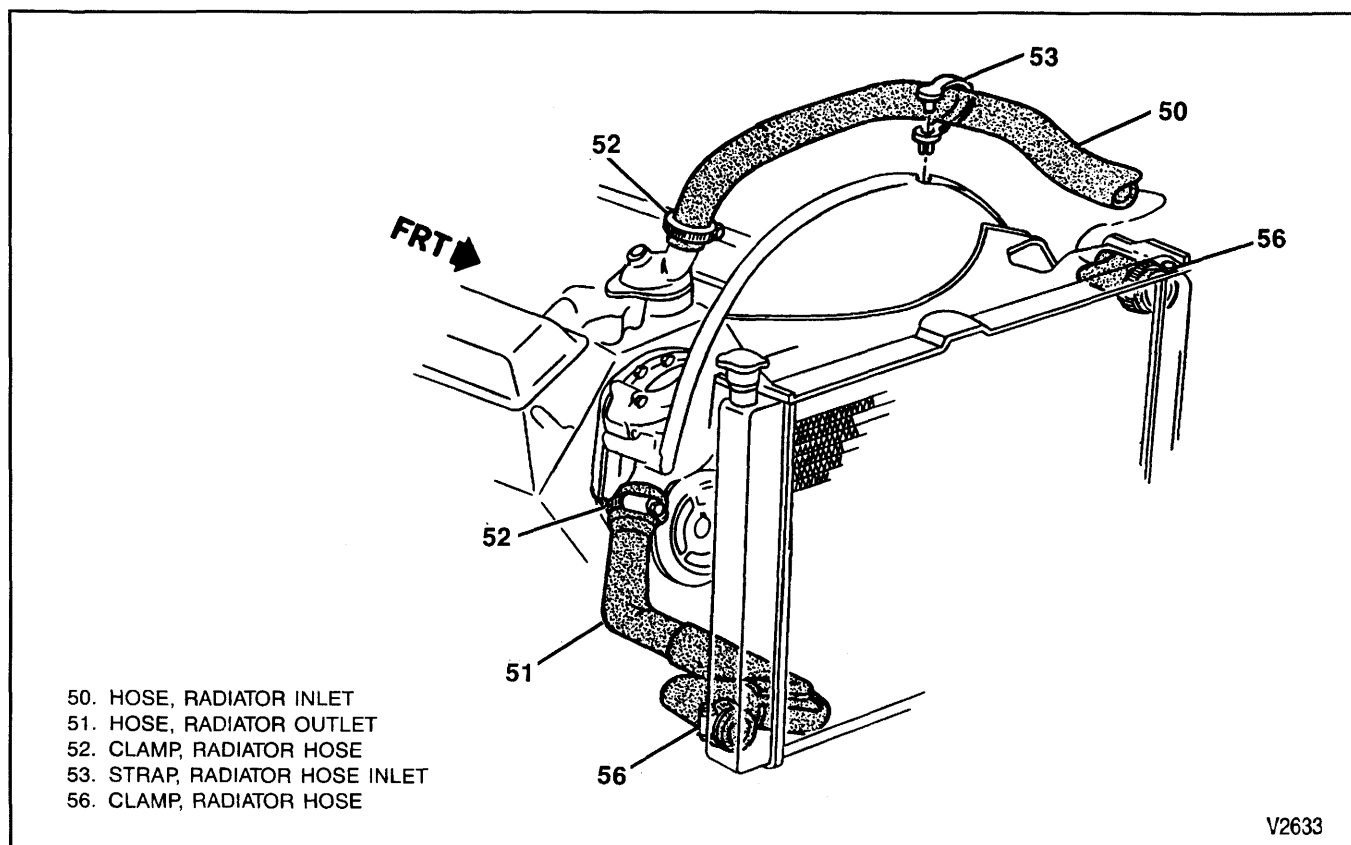


Figure 10—Radiator and Hoses (4.3L Engine)

NOTICE: For steps 2 and 4, refer to "Notice" on page 6B1-1.

1. Fan (15) to the fan clutch (16).
2. Bolts (14).



Tighten

- Bolts (14) to 24 N.m (18 lbs. ft.).
3. Fan and clutch assembly to the coolant pump pulley.
 4. Nuts (17).
 - Align the yellow reference marks on the coolant pump pulley and the fan clutch hub.



Tighten

- Nuts (17) to 24 N.m (18 lbs. ft.).
5. Fan shroud. Refer to SECTION 6B2.

AUXILIARY COOLING FAN REPLACEMENT

The auxiliary cooling fan provides additional cooling for low-speed vehicle operations, extended idle, stop-and-go conditions, and running the air conditioning system.

The auxiliary cooling fan circuit consists of a coolant temperature sensor, relay, and auxiliary fan. When the coolant sensor reaches a predetermined temperature, it closes the circuit to the relay coil. This energizes the relay, applying 12 volts to the auxiliary fan. When the coolant temperature decreases below the setpoint of

the sensor, the circuit to the relay opens and voltage is no longer applied to the auxiliary fan. The cooling fan only operates when the ignition is on and the coolant temperature sensor is above the set temperature.

Refer to figure 15 for the auxiliary cooling fan circuit diagram, and figure 16 for auxiliary cooling fan system diagnosis.

FAN RELAY



Remove or Disconnect (Figure 17)

1. Negative battery cable. Refer to SECTION 0A.
2. Wiring harness connector.
3. Fan relay (141) from inner fender panel.



Install or Connect (Figure 17)

1. Fan relay (141) to inner fender panel.
2. Wiring harness connector.
3. Negative battery cable. Refer to SECTION 0A.

ENGINE COOLANT TEMPERATURE SENSOR



Remove or Disconnect (Figure 17)

1. Negative battery cable. Refer to SECTION 0A.
2. Wiring harness connector (144).
3. Engine coolant temperature sensor (145).



Install or Connect (Figure 17)

NOTICE: Refer to "Notice" on page 6B1-1.

V2633

- 50. HOSE, RADIATOR INLET
- 51. HOSE, RADIATOR OUTLET
- 52. CLAMP, RADIATOR HOSE
- 56. CLAMP, RADIATOR HOSE
- 57. STRAP, RADIATOR OUTLET HOSE
- 58. SUPPORT, RADIATOR INLET HOSE
- 59. BOLT, RADIATOR INLET HOSE SUPPORT

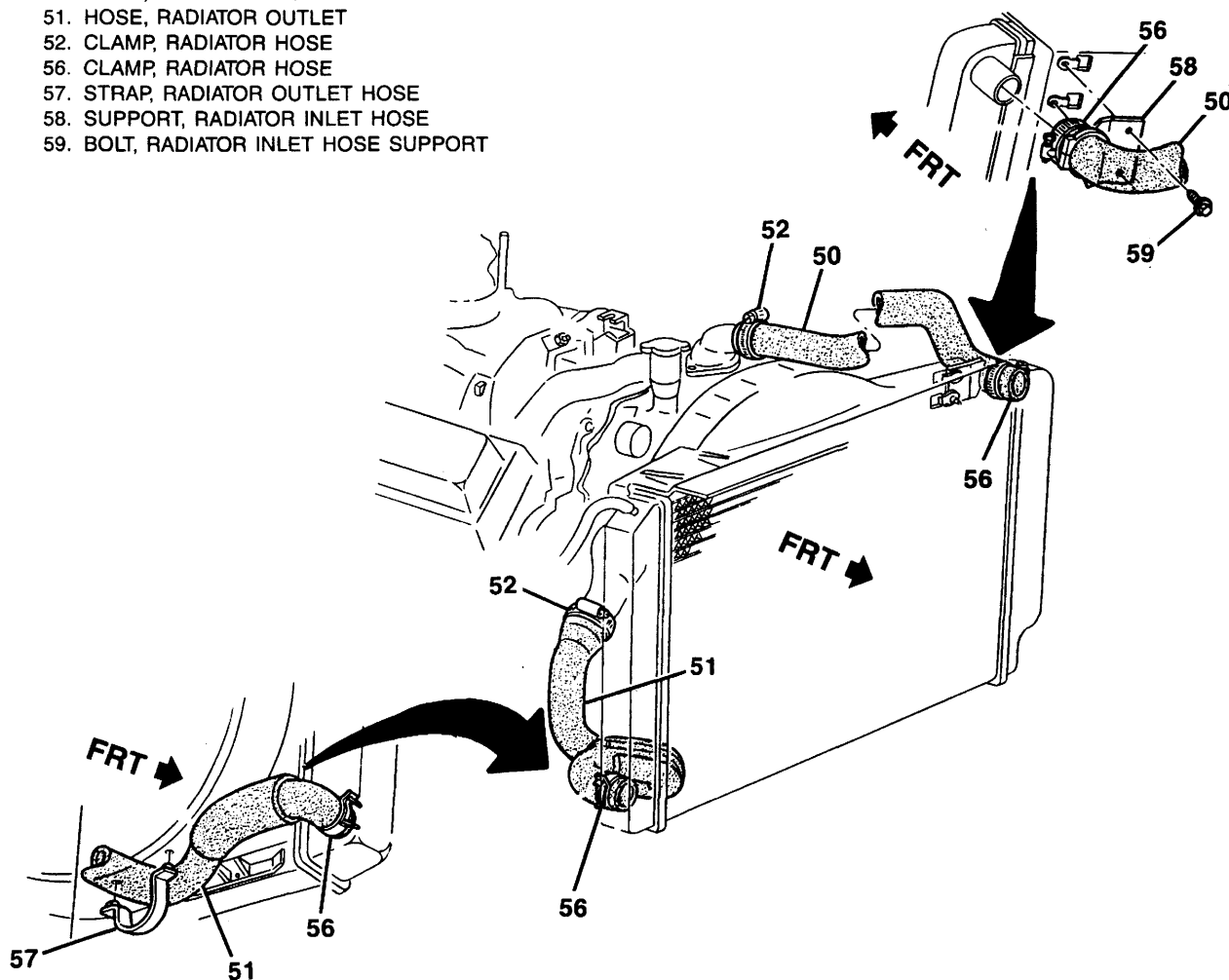


Figure 11—Radiator and Hoses (5.0L, 5.7L, and 7.4L Engines)

1. Engine coolant temperature sensor (145).



Tighten

- Engine coolant temperature sensor to 23 N.m (17 lbs. ft.).

2. Wiring harness connector (144).
3. Negative battery cable. Refer to SECTION 0A.

THERMOSTAT REPLACEMENT

GASOLINE ENGINES

- Remove or Disconnect (Figures 18 through 20)**

1. Drain the cooling system until the radiator coolant level is below the thermostat.
2. Bolts or studs.
3. Coolant outlet.
4. Thermostat from its housing.
5. Gasket (if necessary).



Clean

- Thermostat housing and coolant outlet sealing surfaces.



Install or Connect (Figures 18 through 20)

1. Thermostat in its housing.
2. New gasket into position (if necessary).
3. Coolant outlet.

NOTICE: Refer to "Notice" on page 6B1-1.

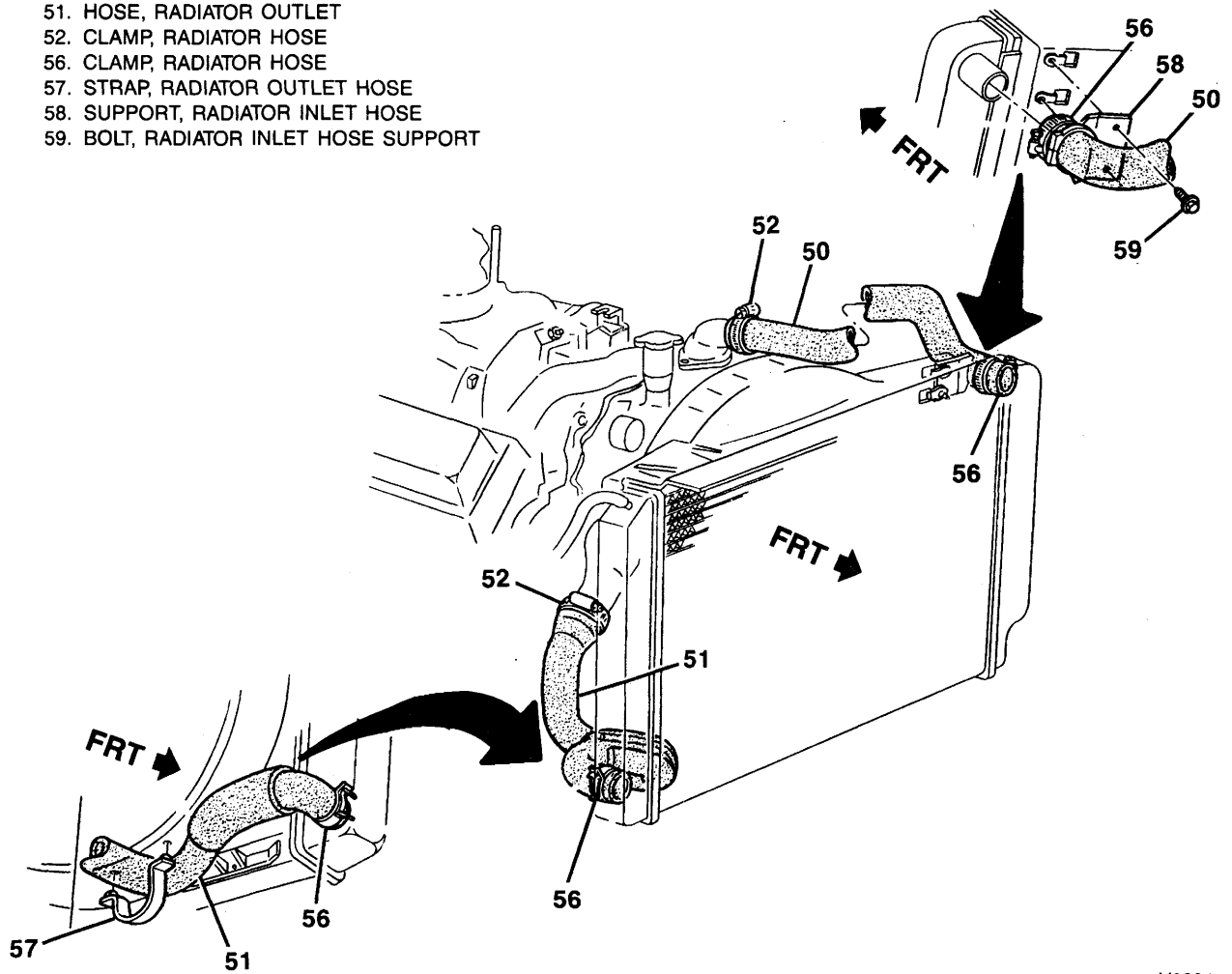
4. Bolt and studs.



Tighten

- Bolts and studs to 28 N.m (21 lbs. ft.) on 4.3L, 5.0L, and 5.7L engines.
 - Studs to 37 N.m (27 lbs. ft.) on 7.4L engines.
5. Fill the cooling system.
 6. Start the engine and run with the radiator cap removed until the radiator upper hose becomes hot (thermostat is open).

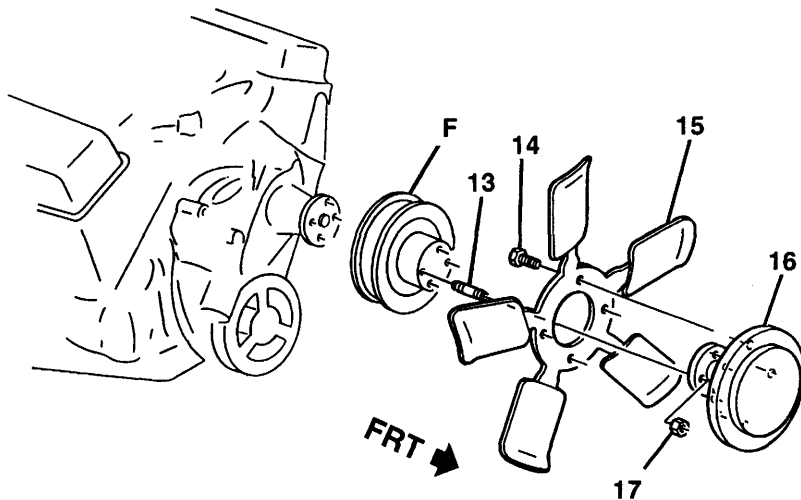
- 50. HOSE, RADIATOR INLET
- 51. HOSE, RADIATOR OUTLET
- 52. CLAMP, RADIATOR HOSE
- 56. CLAMP, RADIATOR HOSE
- 57. STRAP, RADIATOR OUTLET HOSE
- 58. SUPPORT, RADIATOR INLET HOSE
- 59. BOLT, RADIATOR INLET HOSE SUPPORT



V2634

Figure 12—Radiator and Hoses (Diesel Engines)

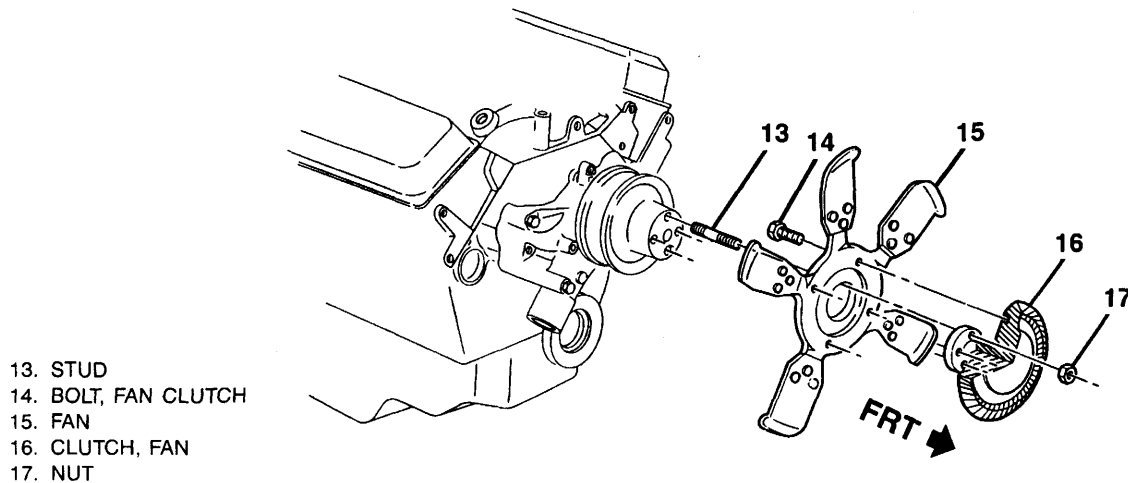
- F. PULLEY, COOLANT PUMP
- 13. STUD
- 14. BOLT, FAN CLUTCH
- 15. FAN
- 16. CLUTCH, FAN
- 17. NUT



V2864

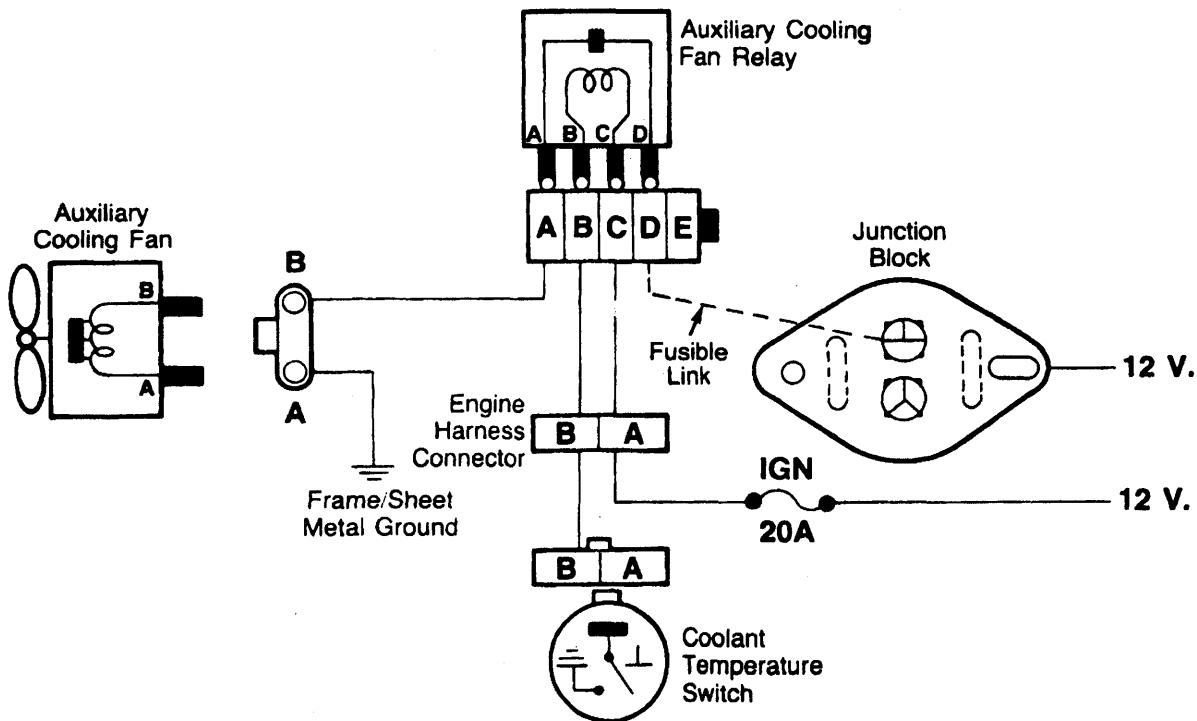
Figure 13—Fan and Fan Clutch (Gasoline Engines)

6B1-16 ENGINE COOLING



V2775

Figure 14—Fan and Fan Clutch (Diesel Engines)



L0799

Figure 15—Auxiliary Cooling Fan Circuit Diagram

7. With the engine idling, add coolant to the radiator until the coolant level reaches the bottom of the filler neck.
8. Radiator cap to the radiator, making sure the arrows line up with the overflow tube.
9. Check for leaks.

2. Drain the cooling system until the radiator coolant level is below the thermostat.
3. Engine oil dipstick tube brace and the oil fill brace. Refer to SECTION 6A6.
4. Upper radiator (inlet) hose.
5. Bolt (24), stud (20), and the coolant outlet (21).
6. Gasket (22).
7. Thermostat (23) from its housing.

DIESEL ENGINES

↔ Remove or Disconnect (Figure 21)

1. Upper fan shroud. Refer to SECTION 6B2.

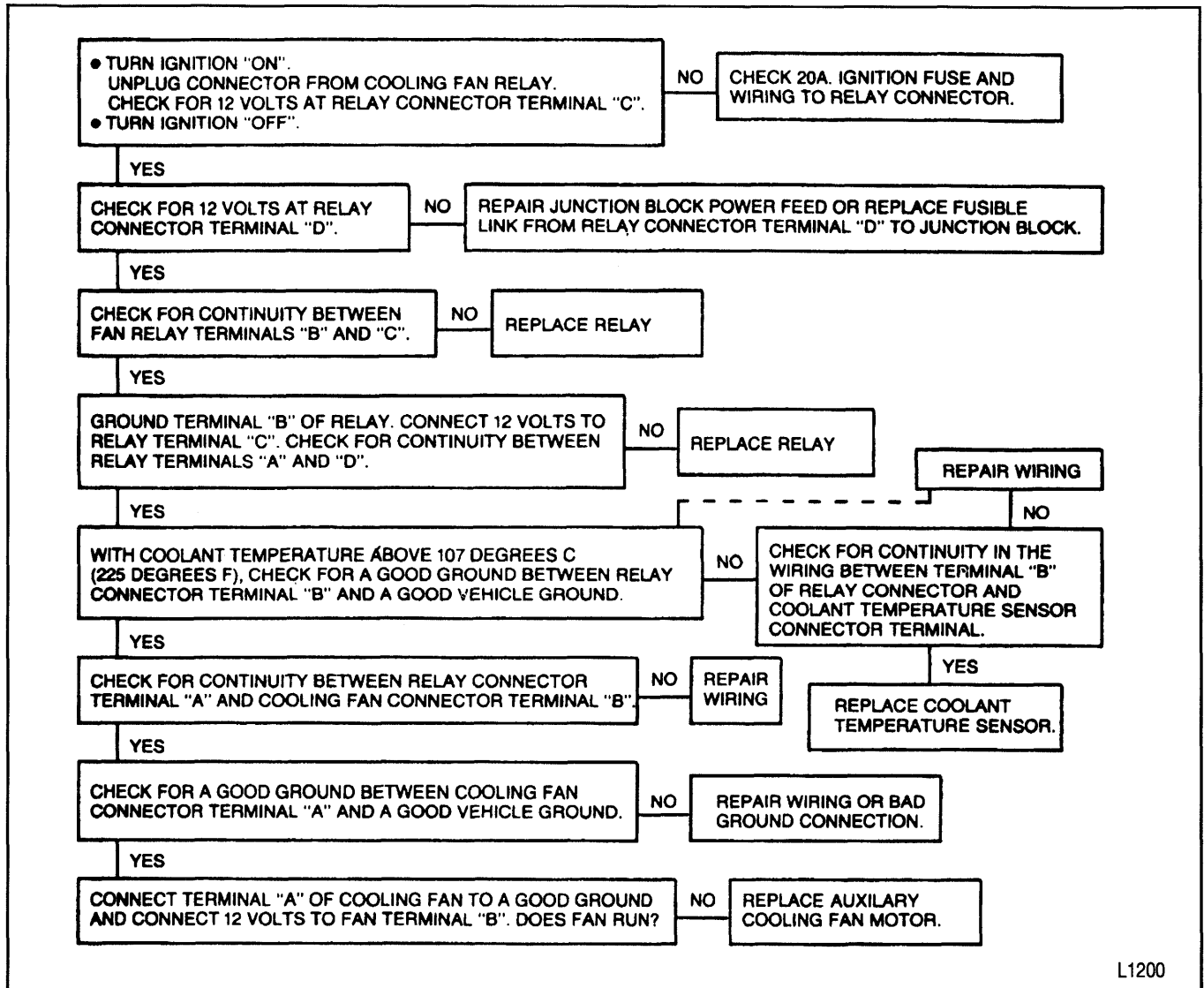


Figure 16—Auxiliary Cooling Fan System Diagnosis



Clean

- Thermostat housing and coolant outlet sealing surfaces.



Install or Connect (Figure 21)

1. Thermostat (23) into its housing.
2. Gasket (22) into position.
3. Coolant outlet (21).

NOTICE: Refer to "Notice" on page 6B1-1.

4. Bolt (24) and stud (20).



Tighten

- Bolt (24) and stud (22) to 42 N.m (31 lbs. ft.).
5. Upper radiator (inlet) hose.
 6. Engine oil dipstick tube brace and the oil fill brace. Refer to SECTION 6A6.
 7. Upper fan shroud. Refer to SECTION 6B2.
 8. Fill the cooling system.

9. Start the engine and run with the radiator cap removed, until the upper radiator hose becomes hot (thermostat is open).
10. With the engine idling, add coolant to the radiator until the coolant level reaches the bottom of the filler neck.
11. Radiator cap to the radiator, making sure the arrows line up with the overflow tube.
12. Check for leaks.

THERMOSTAT HOUSING CROSSOVER REPLACEMENT

DIESEL ENGINES

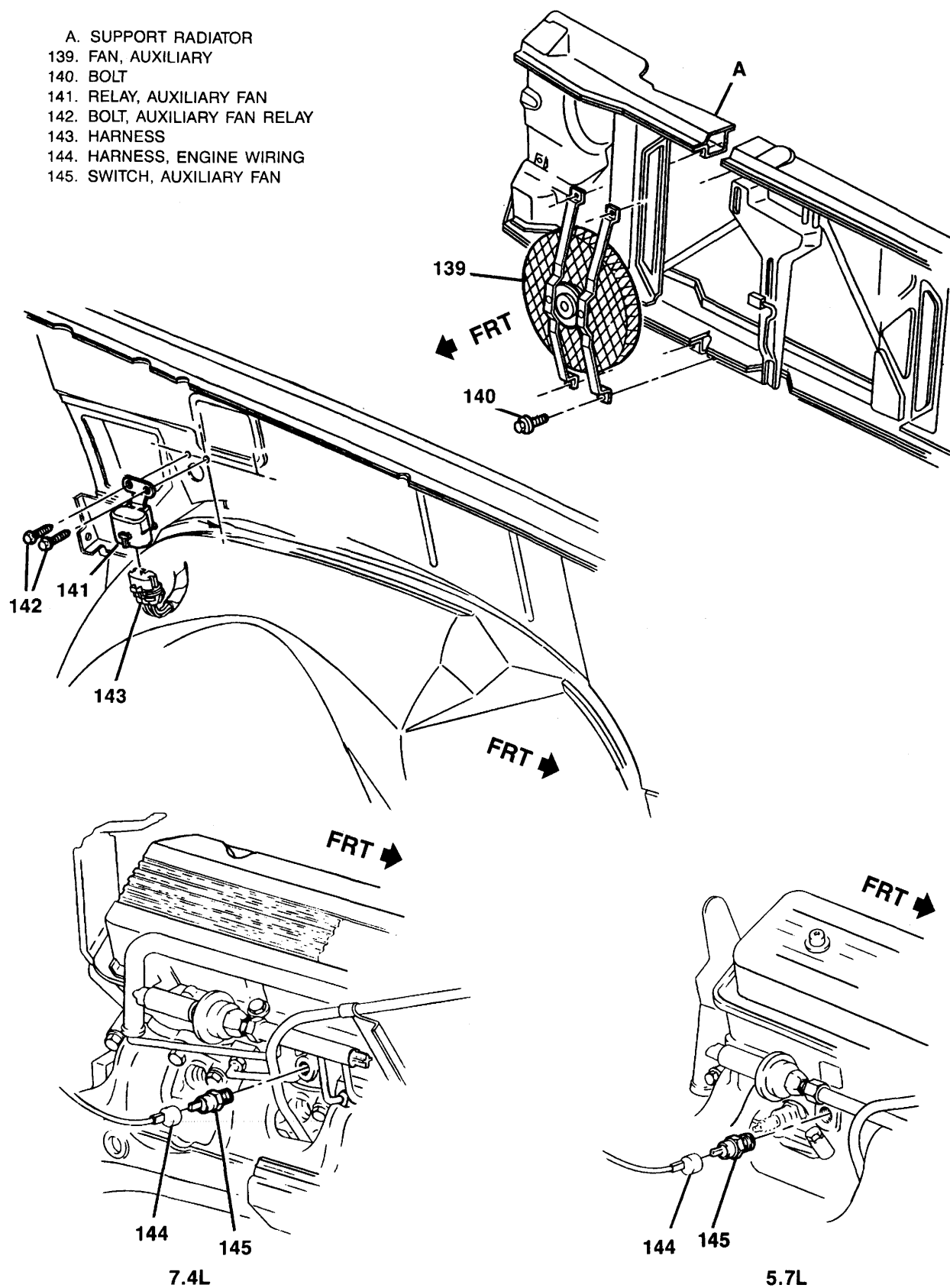


Remove or Disconnect (Figure 22)

1. Coolant from the radiator.
2. Crankcase depression regulator valve.
3. Generator upper bracket.
4. Bypass hose (47), upper radiator (inlet) hose, and heater hose.
5. Studs (44) and bolts (45).

L1200

6B1-18 ENGINE COOLING



V2865

Figure 17—Auxiliary Cooling Fan System Components

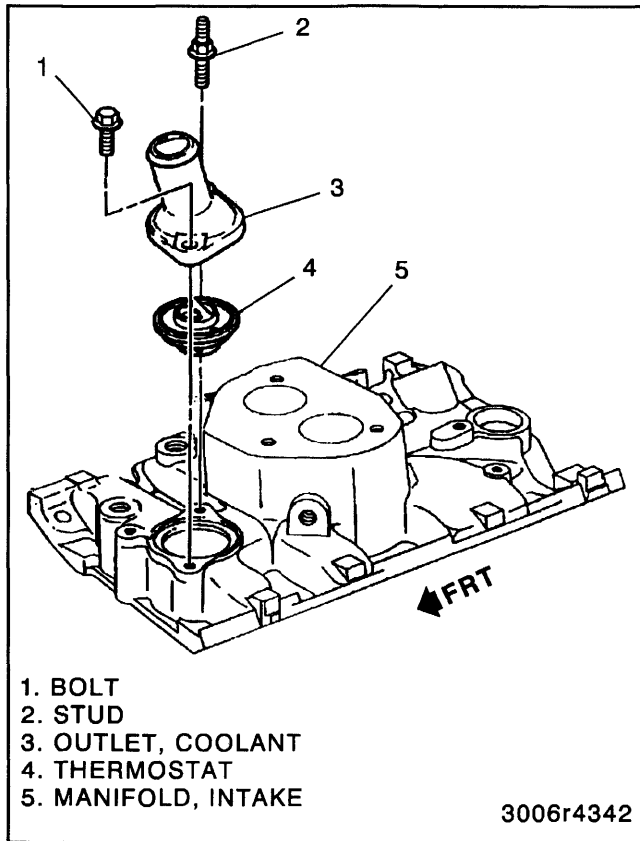


Figure 18—Thermostat and Components (4.3L Engine)

6. Coolant crossover housing assembly (42) from the vehicle.

- The thermostat and coolant outlet are attached to the crossover housing assembly along with the thermal bypass nipple.



Clean

- Coolant crossover housing sealing surfaces.



Install or Connect (Figure 22)

1. New gaskets (40).
2. Coolant crossover housing assembly (42).

NOTICE: Refer to "Notice" on page 6B1-1.

3. Studs (44) and bolts (45).



Tighten

- Studs (44) and bolts (45) to 42 N·m (31 lbs. ft.).
4. Heater hose, upper radiator (inlet) hose, and bypass hose (47).
 5. Generator upper bracket.
 6. Crankcase depression regulator valve.
 7. Coolant in the radiator.
 8. Start the engine and run, with the radiator cap removed, until the upper radiator hose becomes hot (thermostat is open).

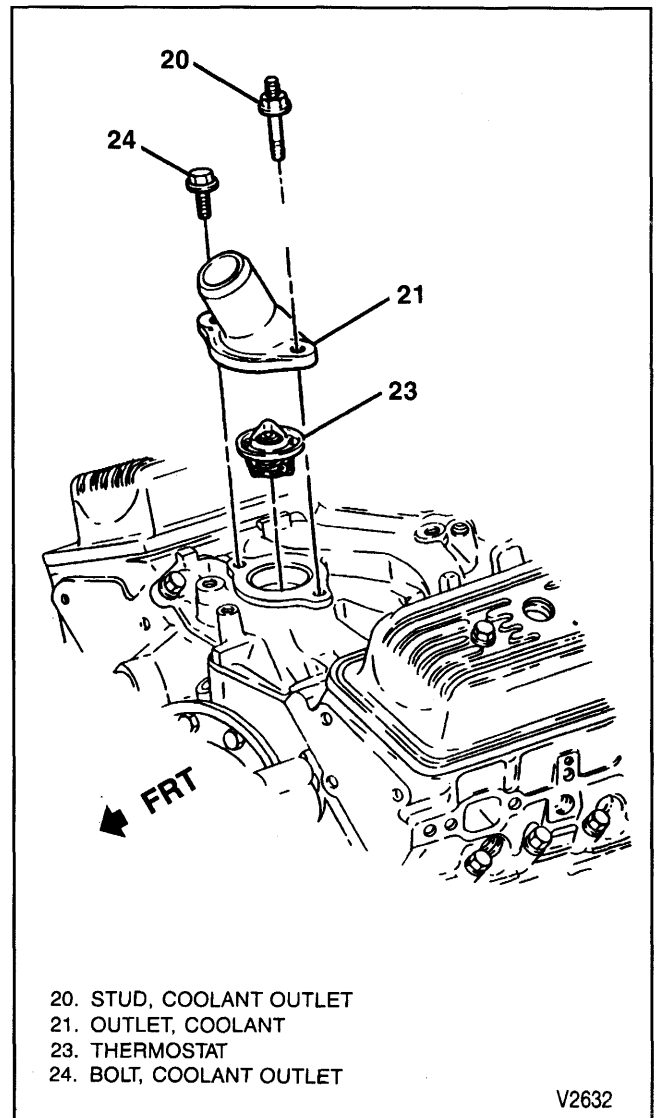


Figure 19—Thermostat and Components (5.0L and 5.7L Engines)

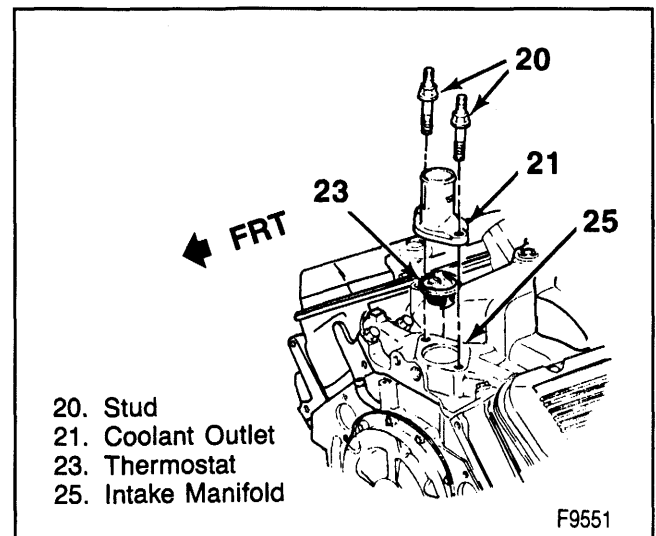


Figure 20—Thermostat and Components (7.4L Engine)

6B1-20 ENGINE COOLING

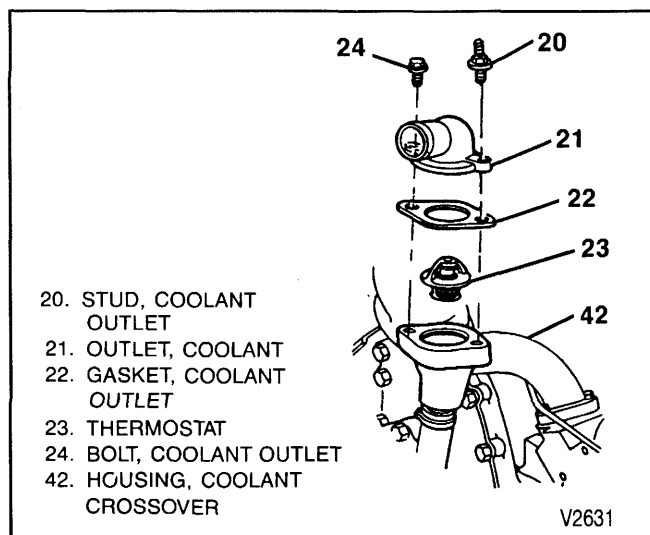


Figure 21—Thermostat and Components (Diesel Engines)

9. With the engine idling, add coolant to the radiator until the coolant level reaches the bottom of the filler neck.
10. Radiator cap to the radiator, making sure the arrows line up with the overflow tube.
11. Check for leaks.

COOLANT PUMP REPLACEMENT

GASOLINE ENGINES

↔ Remove or Disconnect (Figures 23, 24, and 25)

1. Coolant from the radiator.
2. Upper fan shroud. Refer to SECTION 6B2.
3. Drive belt. Refer to "Drive Belt Replacement."
4. Fan, fan clutch, and pulley from the coolant pump. Refer to "Fan and Fan Clutch Replacement."
5. Lower radiator (outlet) hose and heater hose from the coolant pump.
 - On the 7.4L engine, remove the bypass hose.
6. Bolts.

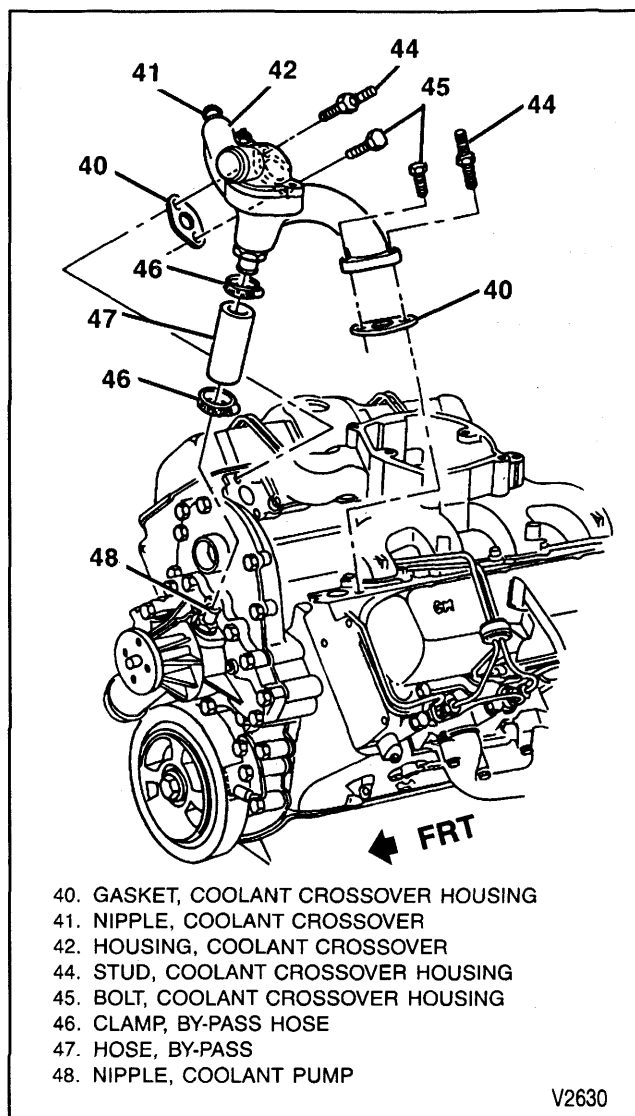


Figure 22—Coolant Crossover and Components (Diesel Engines)

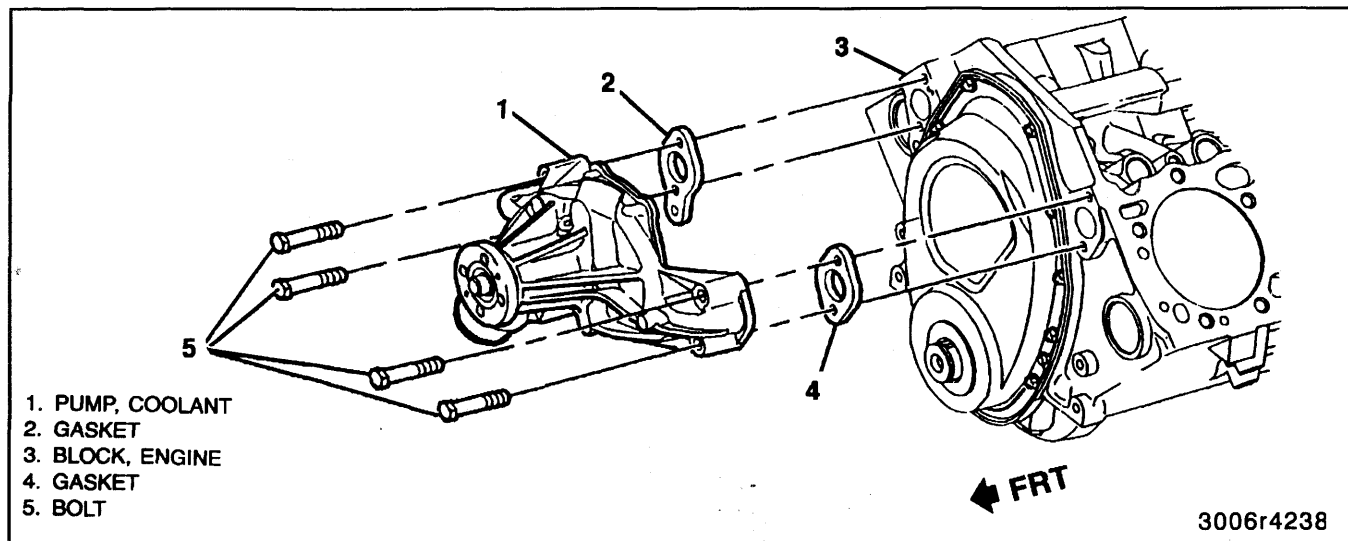


Figure 23—Coolant Pump and Components (4.3L Engine)

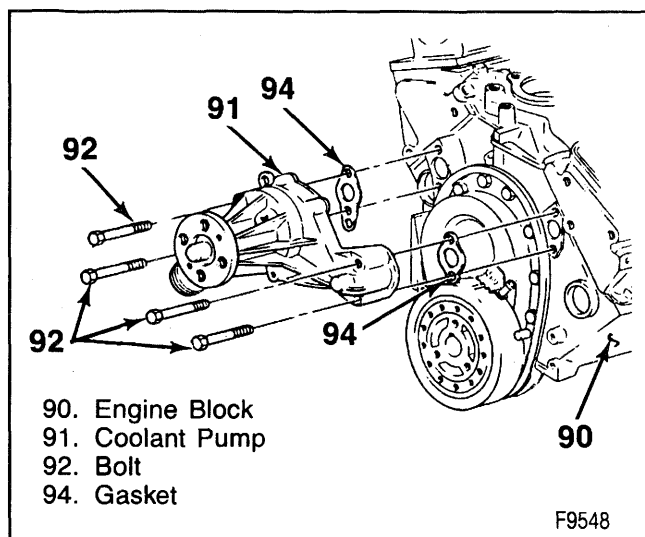


Figure 24—Coolant Pump and Components (5.0L and 5.7L Engines)

7. Coolant pump from the engine block.



Clean

- Mating surfaces on the coolant pump and the engine block.



Install or Connect (Figures 23, 24, and 25)

NOTICE: For steps 3 and 6, refer to “Notice” on page 6B1-1.

1. Coolant pump to the engine block.
2. New gaskets.
3. Bolts.



Tighten

- Bolts to 41 N·m (30 lbs. ft.).
4. Lower radiator (outlet) hose and heater hose to the coolant pump.
 - Bypass hose on the 7.4L engine.
 5. Coolant pump pulley, fan, and fan clutch to the coolant pump hub. Refer to “Fan and Fan Clutch Replacement.”
 6. Drive belt. Refer to “Drive Belt Replacement.”
 7. Upper fan shroud. Refer to SECTION 6B2.
 8. Start the engine and run, with the radiator cap removed, until the upper radiator hose becomes hot (thermostat is open).
 9. Add coolant to the radiator until the level reaches the bottom of the filler neck.
 - Engine must be running at idle speed.
 10. Radiator cap, making sure the arrows line up with the overflow tube.
 11. Check for leaks.

DIESEL ENGINES



Remove or Disconnect (Figure 26)

1. Negative battery cable. Refer to SECTION 0A.

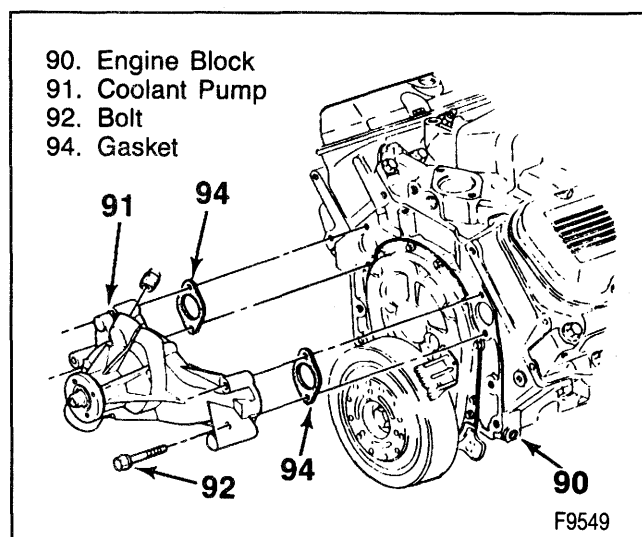


Figure 25—Coolant Pump and Components (7.4L Engine)

2. Coolant from the radiator.
3. Fan shroud. Refer to SECTION 6B2.
4. Fan. Refer to “Fan and Fan Clutch Replacement.”
5. Drive belt. Refer to “Drive Belt Replacement.”
6. Raise vehicle. Support with safety stands.
7. Vacuum pump mounting bracket nuts.
8. Bolt holding vacuum pump bracket and generator.
9. Vacuum pump with bracket.
10. Power steering pump lay aside. Refer to SECTION 3B1.
11. Power steering pump mounting bracket. Refer to SECTION 3B1.
 - Lower vehicle.
12. Lower radiator hose from pump.
13. Bypass hose from pump.
14. Bolts (90, 92, and 96), studs (93 and 97), coolant pump plate (99), and the coolant pump (91) (figure 26).
15. Bolt (98) from the rear of the coolant pump plate.
16. Coolant pump (91) and gasket (94) from the plate (99).



Clean

- All flanges must be free of oil. Clean the mating surfaces on the coolant pump, both sides of the coolant pump plate, and the engine block.



Install or Connect (Figure 26)

NOTICE: For steps 3, 5, and 9, refer to “Notice” on page 6B1-1.

1. Gasket (94).
2. Coolant pump (91) to the coolant pump plate (99).
3. Bolt (98).



Tighten

- Bolt (98) to 23 N·m (17 lbs. ft.).
4. Coolant pump (91) and coolant pump plate (99) to the engine.

6B1-22 ENGINE COOLING

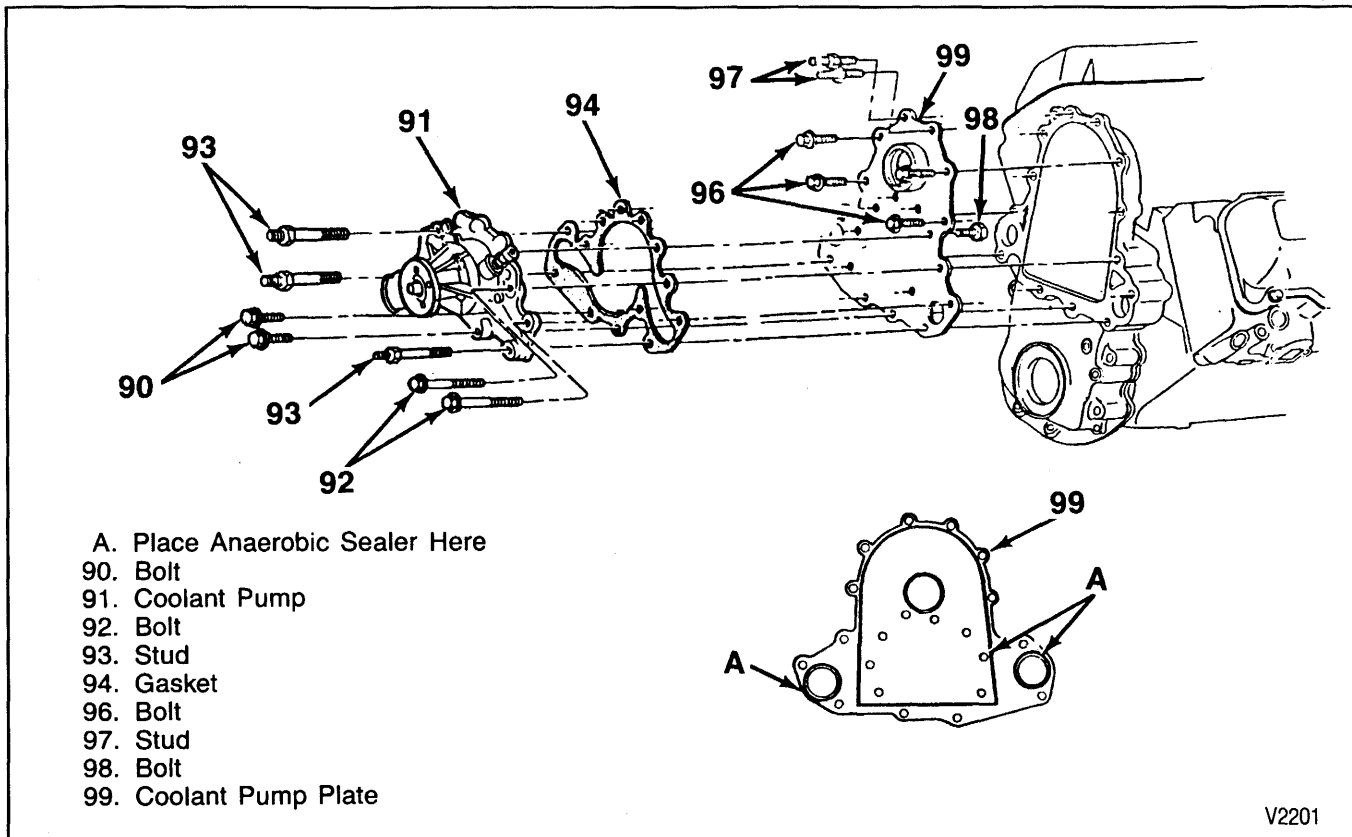


Figure 26—Coolant Pump and Components (Diesel Engines)

- Apply anaerobic sealer (GM P/N 1052357).
- The sealer must be wet to the touch when the bolts are tightened.

5. Bolts (90, 92, and 96) and studs (93 and 97).



Tighten

- Bolts (90 and 96) and studs (97) to 23 N·m (17 lbs. ft.).
 - Bolts (92) and studs (93) to 42 N·m (31 lbs. ft.).
6. Bypass hose and lower radiator hose.
- Raise vehicle. Support with safety stands.
7. Power steering bracket and pump. Refer to SECTION 3B1.
8. Vacuum pump and bracket.
9. Bolt holding vacuum pump and generator. Refer to SECTION 6H.
- Lower vehicle.
10. Fan and pulley. Refer to "Fan Clutch Replacement."
11. Drive belt. Refer to "Drive Belt Replacement."
12. Fan shroud. Refer to SECTION 6B2.
13. Negative battery cable.
14. Coolant in the radiator or surge tank. Refer to "Draining and Filling the Cooling System."
15. Radiator or surge tank cap, making sure the arrows line up with the overflow tube.
16. Check for leaks.

DRIVE BELT TENSIONER INSPECTION



Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
 2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement."
- Position a hex head socket on the belt tensioner pulley bolt head.
 - Move the drive belt tensioner through its full travel.

NOTICE: Do not allow the drive belt tensioner to snap into the "free" position. This may result in damage to the tensioner.

- Movement should feel smooth and return freely without any binding. If any binding is observed, replace the tensioner.



Install or Connect

1. Multiple ribbed drive belt. Refer to "Drive Belt Replacement."
2. Negative battery cable.

DRIVE BELT TENSIONER REPLACEMENT

←→ Remove or Disconnect (Figures 27 through 33)

1. Negative battery cable.
2. Multiple ribbed drive belt. Refer to "Drive Belt Replacement."
3. Bolt (111).
4. Nut (120), diesel engines only.

5. Tensioner (110).

→→ Install or Connect (Figures 27 through 33)

1. Tensioner (110) to mounting bracket.

NOTICE: For steps 2 and 3 refer to "Notice" on page 6B1-1.

2. Bolt (111), gasoline engines only.

⌚ Tighten

- Bolt (111) to 83 N·m (61 lbs. ft.).

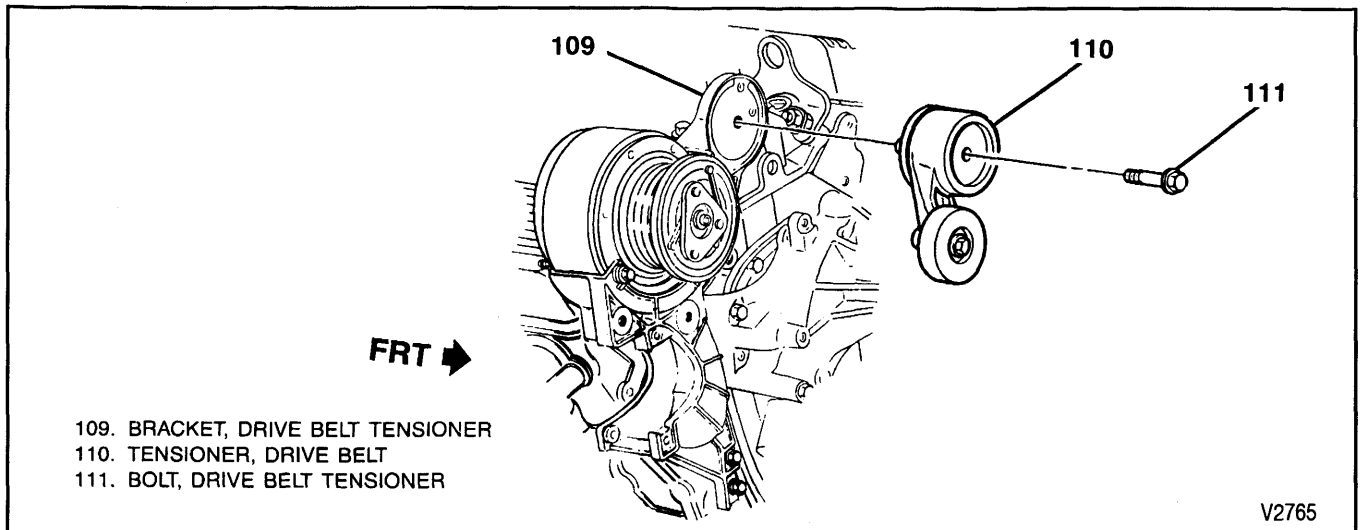


Figure 27—Belt Tensioner Assembly (4.3L, 5.0L, and 5.7L Engines)

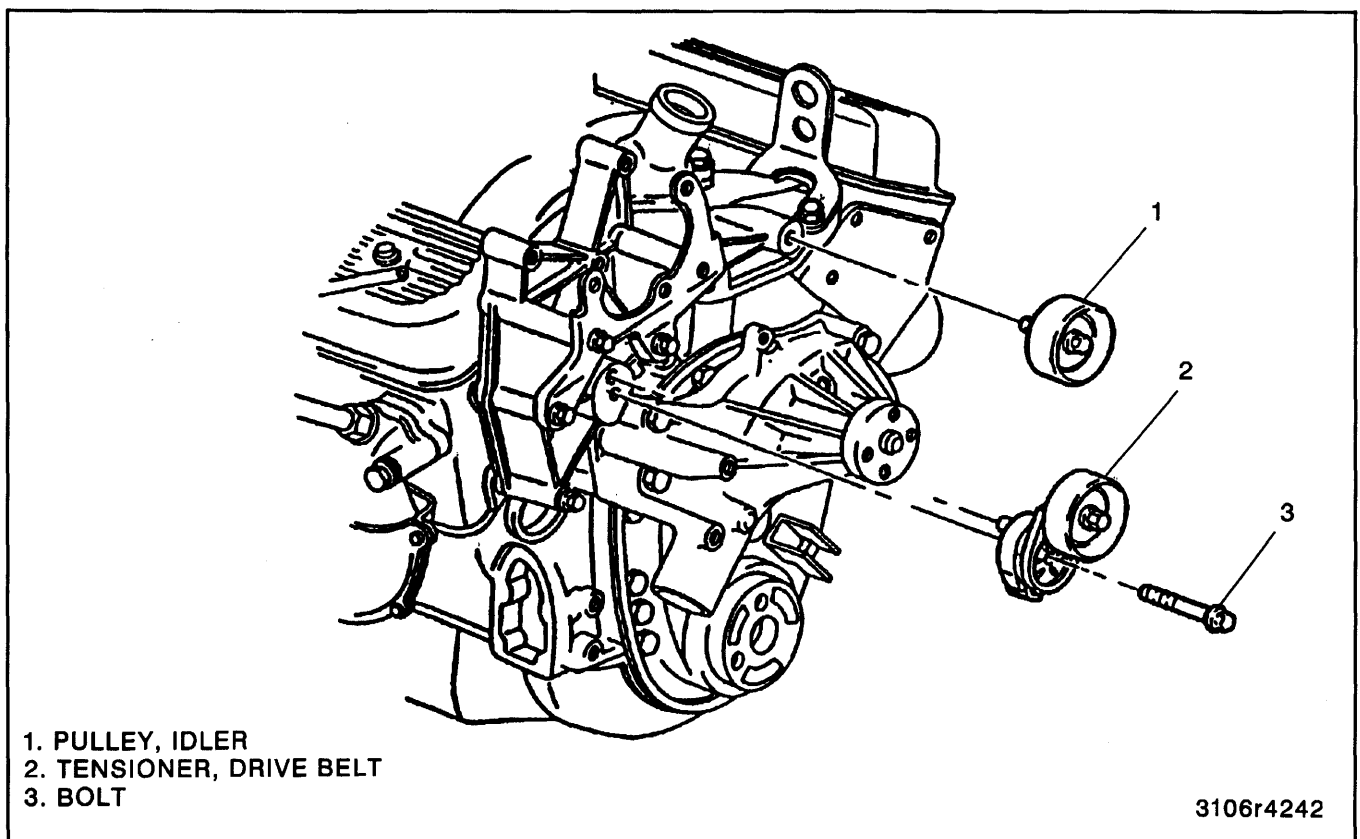


Figure 28—Belt Tensioner Assembly (C/K 2 and 3 with 7.4L Engine and A/C)

6B1-24 ENGINE COOLING

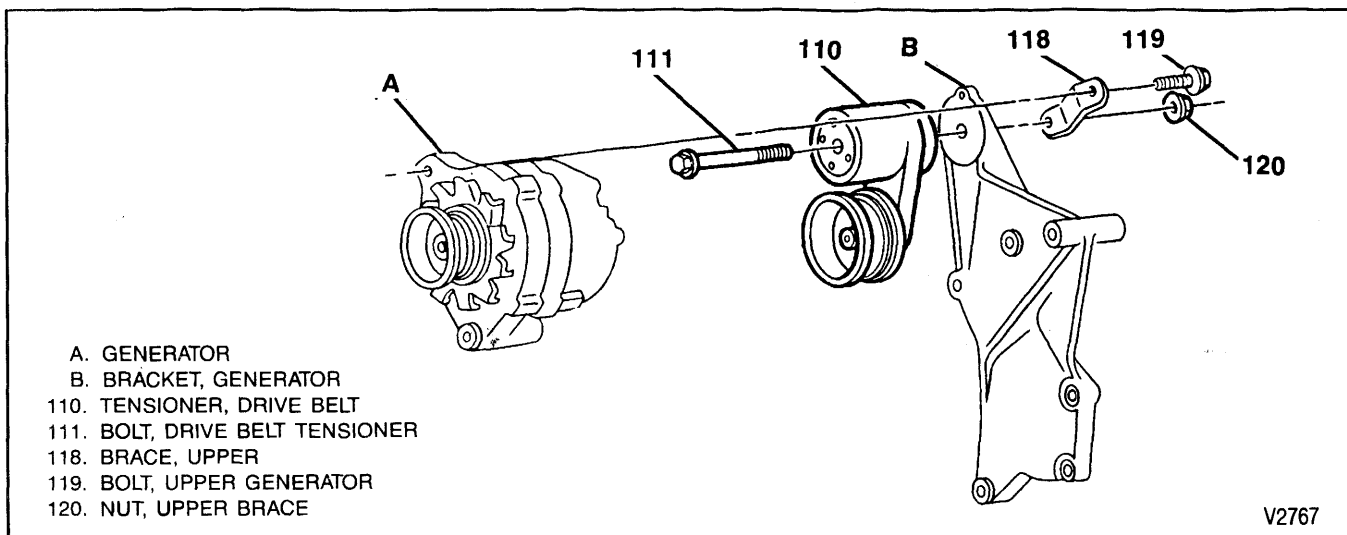


Figure 29—Belt Tensioner Assembly (Diesel Engines)

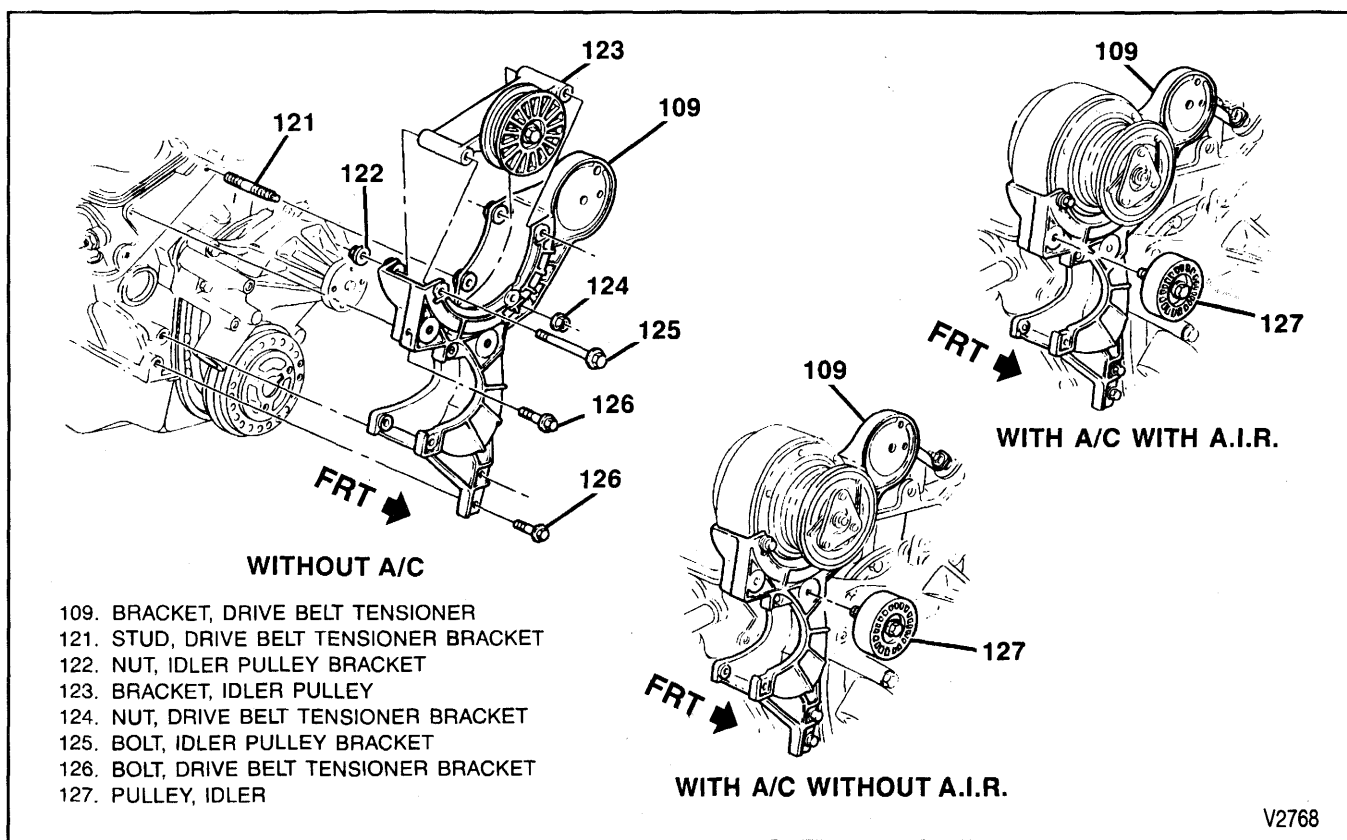


Figure 30—Idler Pulley and Bracket (4.3L, 5.0L, and 5.7L Engines)

3. Bolt (111) and nut (120), diesel engines only.



Tighten

- Nut (120) to 49 N.m (36 lbs. ft.).
4. Multiple ribbed drive belt. Refer to "Drive Belt Replacement."
 5. Negative battery cable.

DRIVE BELT SERVICE

Maintaining the multiple ribbed drive belt and pulleys can extend the normal life of a drive belt.

PULLEY INSPECTION

Examine the pulleys for chips, nicks, tool marks, cracks, bent sidewalls, corrosion, or other damage.

1. Place a straightedge or position a cord across the two pulleys so they touch at all points (figure 34).
2. Turn each pulley one half revolution and recheck with a straightedge or cord. Full contact at all points must be made. If contact is not made at all points, the pulley may be warped or its shaft could be bent. Replace any parts found to be damaged.

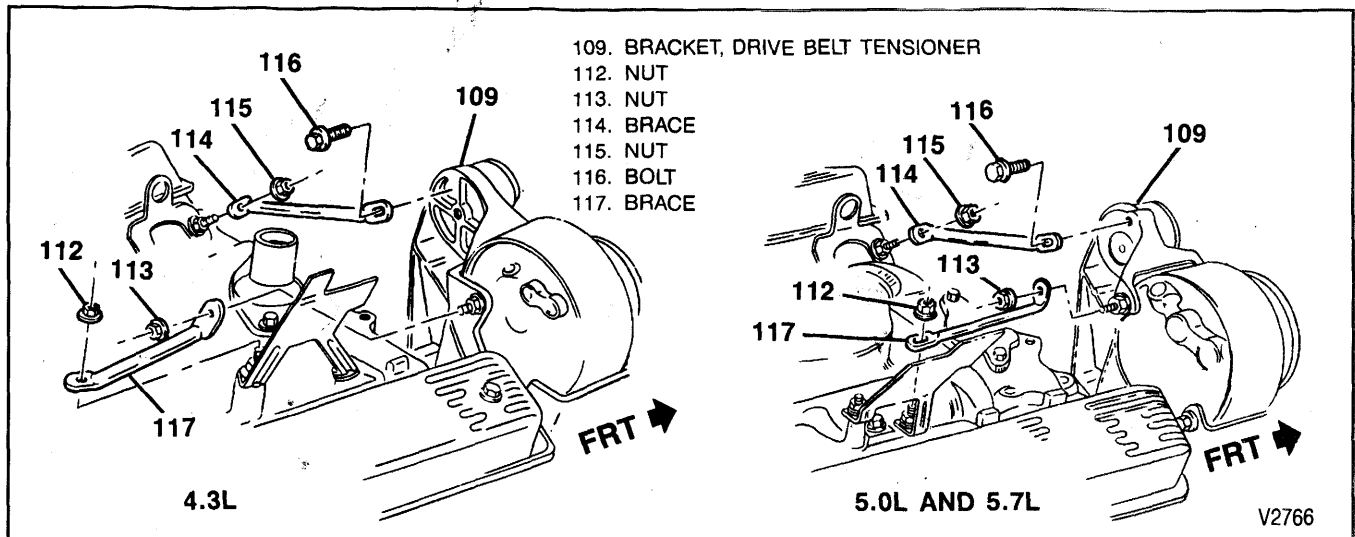


Figure 31—Belt Tensioner Braces (4.3L, 5.0L, and 5.7L Engines with Air Conditioning)

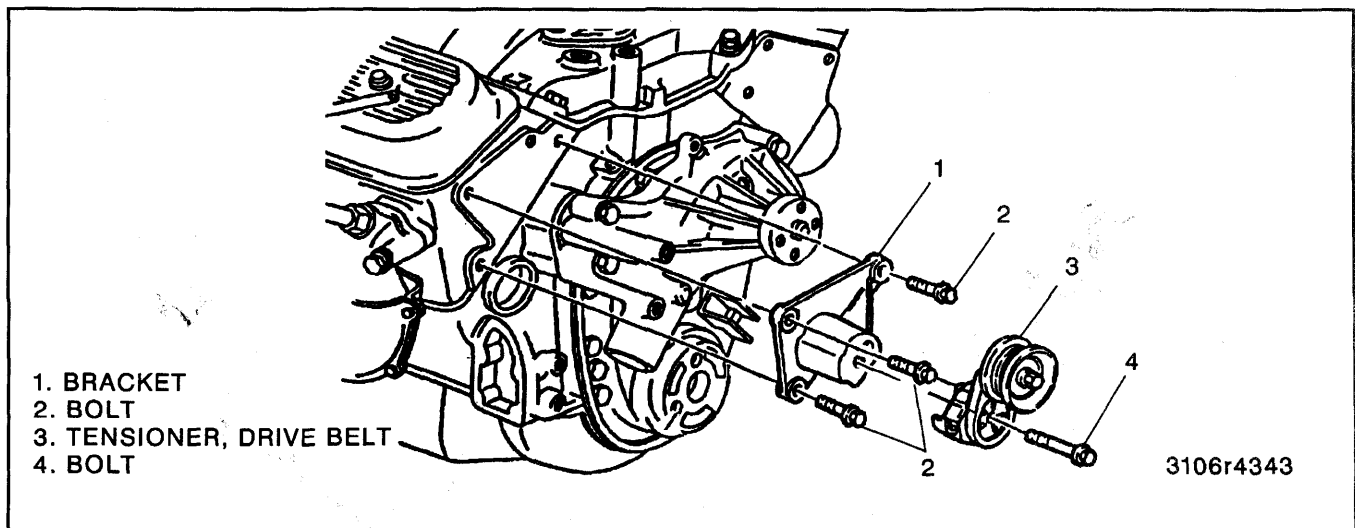


Figure 32—Idler Pulley and Bracket (C/K 2 and 3 with 7.4L Engine without A/C)

3. If the belt becomes loose and squeals or the belt comes off the engine drive pulleys, refer to "Diagnosis of Drive Belt System."

DRIVE BELT INSPECTION

! Important

- Routine inspection of the belt may reveal cracks in the belt ribs. These cracks will not impair belt performance and are not a basis for belt replacement. If sections of the belt are missing, the belt should be replaced.

Do not use drive belt dressings to extend belt life. Use of belt dressing will soften the belts and cause deterioration. Oil or grease contamination on the belt or pulleys will also deteriorate the belt.

DRIVE BELT INSTALLATION

Install a multiple ribbed belt following the belt routings shown in figures 35, 36, 37, and 38. The grooves in the

belt must match the grooves in the pulleys. The tensioner is spring loaded. After removing the belt, the tensioner will return to the tension position.

DRIVE BELT REPLACEMENT

- ↔ Remove or Disconnect (Figures 35 through 38)

NOTICE: Do not allow the drive belt tensioner to snap into the "free" position. This may result in damage to the tensioner.

1. Use a 1/2-inch breaker bar with a socket placed on the tensioner pulley axis bolt and rotate the tensioner to release belt tension.
2. Belt.

- Install or Connect (Figures 35 through 38)

1. Route belt over all the pulleys except the belt tensioner.

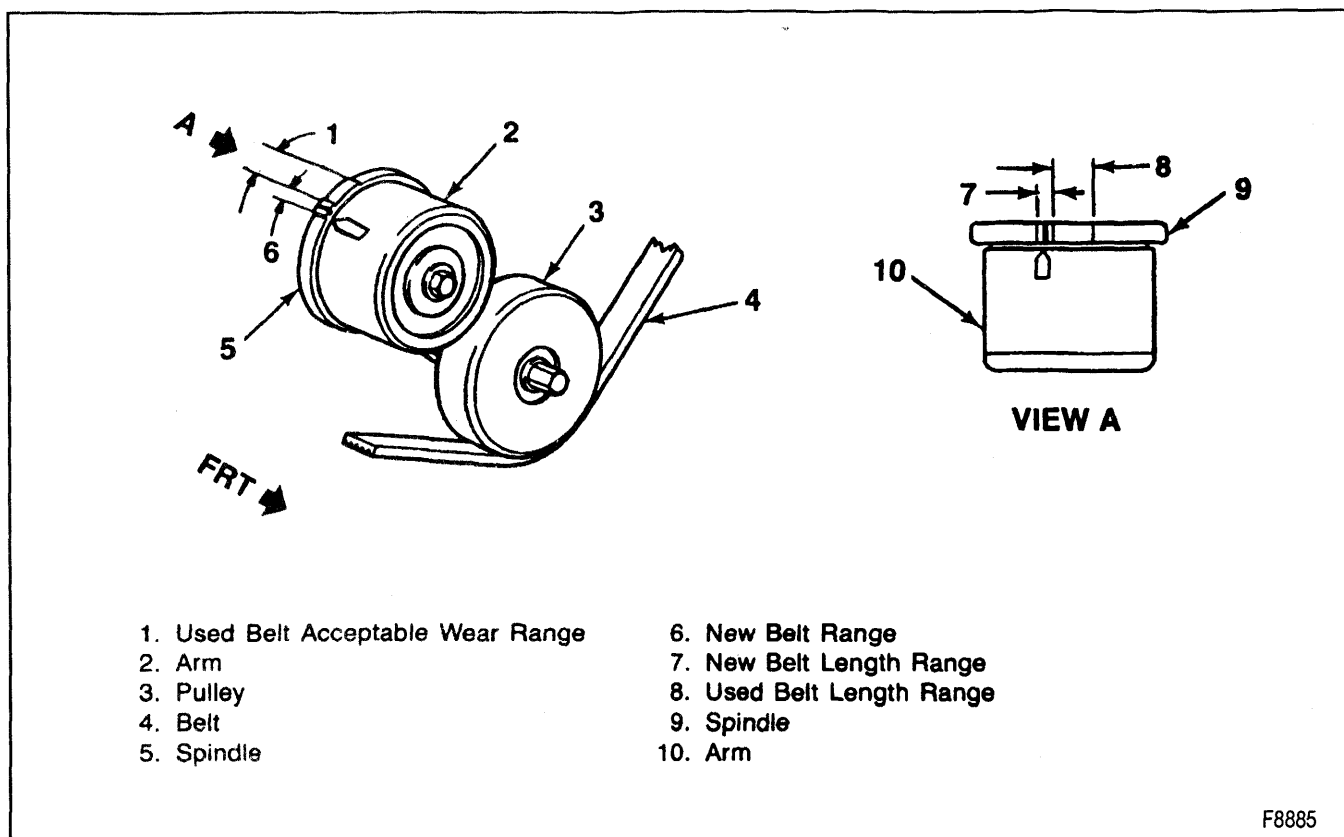


Figure 33—Automatic Belt Tensioner and Belt Length Scale

2. Use a 1/2-inch breaker bar with a socket placed on the tensioner pulley axis bolt and rotate the tensioner to the released position.
3. Belt over the belt tensioner pulley.
4. Check the belt for correct "V" groove tracking around each pulley.

ENGINE OIL COOLER LINE REPLACEMENT

The optional oil cooler is either an integral part of the radiator or a separate unit placed in front of the radiator. If an integral type cooler needs repair, refer to SECTION 6B2. Cooler lines and hoses are serviceable. Refer to figures 39 through 45 for the applicable engine being serviced.

OIL COOLER SYSTEM SERVICE

If foreign material has entered the oil cooler or if the engine has been damaged internally, flush the oil cooler, connecting lines, and filter adapter assembly in the following manner.

Remove or Disconnect (Figures 39 through 48)

- Set the parking brake.
- 1. Oil cooler lines from the connector.
 - Using a small pick-type tool and your thumb (A in figure 46), grasp the connector end and pull the clip from the connector (B in figure 46). This releases the cooler line from the connector.

NOTICE: Do not use more than 690 kPa (100 psi) air to clean the cooler and lines. Exceeding 690 kPa (100 psi) could damage the cooler or lines.

- A. Using clean solvent and compressed air, back-flush the oil cooler and lines.
 - B. Using compressed air, remove the cleaning solvent.
 - C. Flush the system using the same type of oil normally circulated through the cooler.
2. Bolt or nut from bracket or clamp.

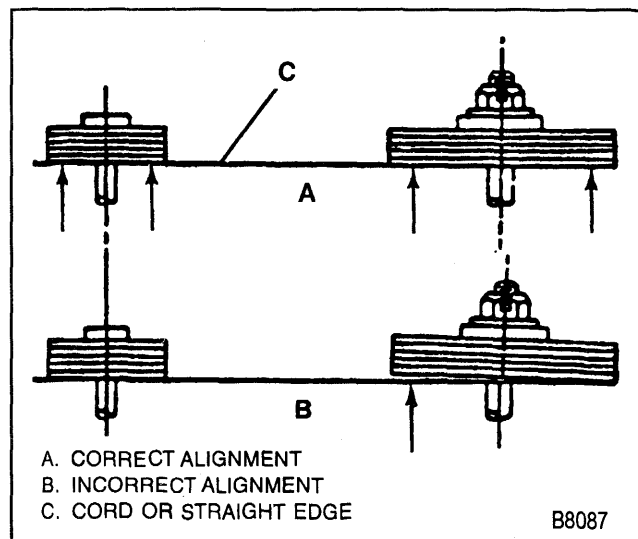


Figure 34—Checking the Pulley Alignment

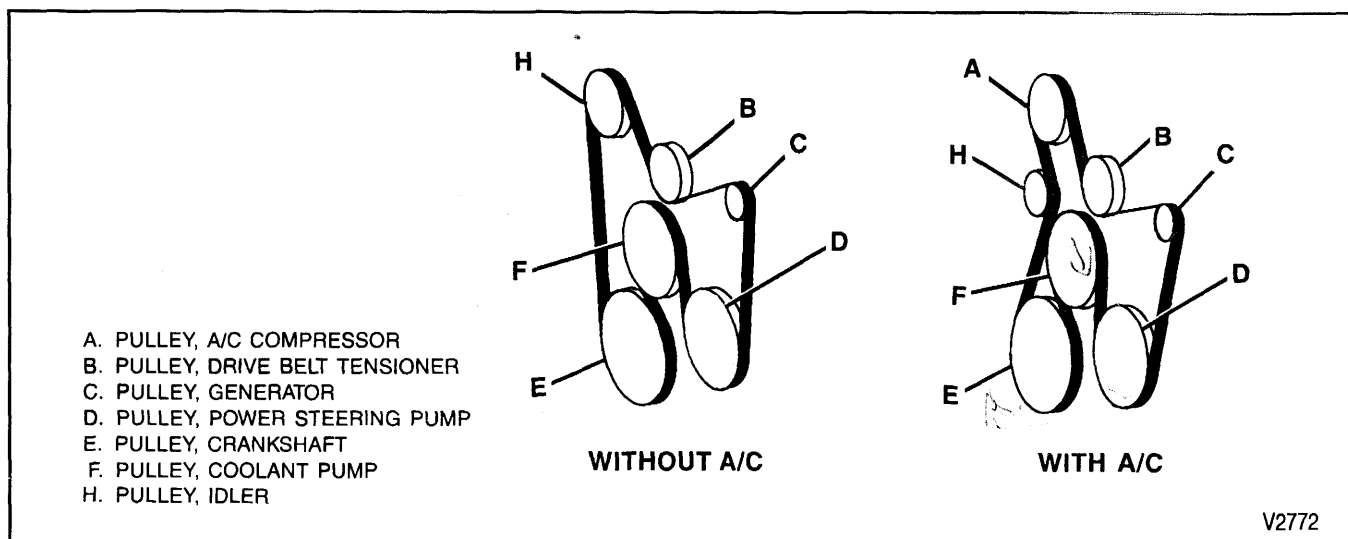


Figure 35—Multiple Rib Drive Belt Routing (4.3L, 5.0L, and 5.7L Engines without A.I.R.)

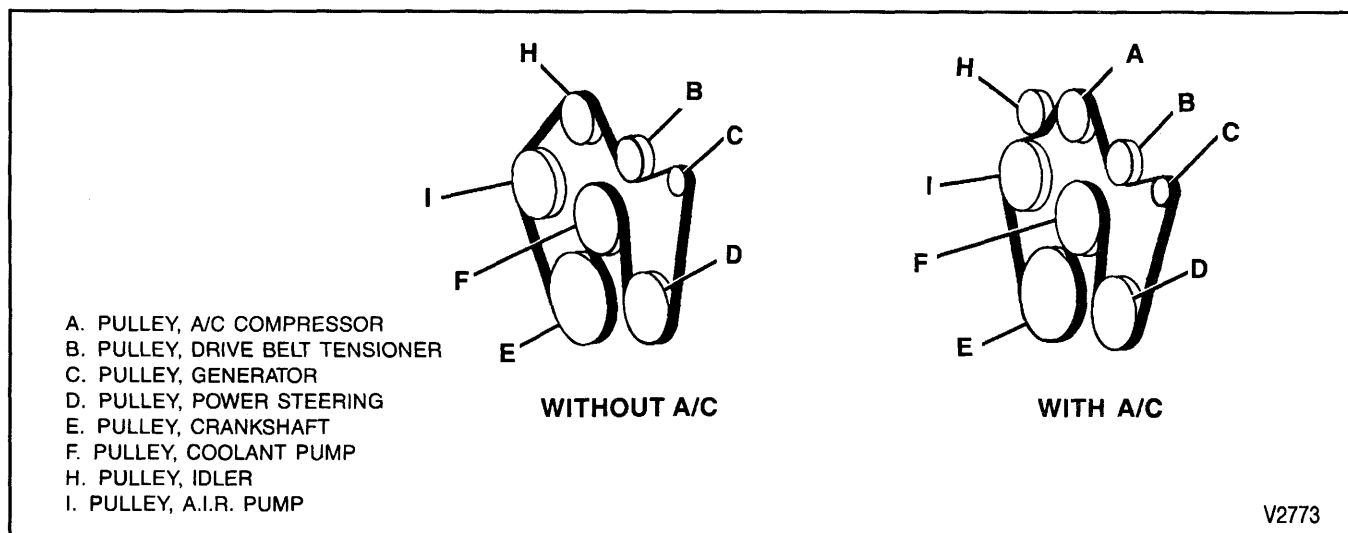


Figure 36—Multiple Rib Drive Belt Routing (4.3L and 5.7L Engines with A.I.R.)

3. Bolt and clip from its bracket (diesel engines only) figure 44.
4. Oil filter and discard.
5. Oil cooler lines from the clip or strap.
6. Oil cooler lines from the oil cooler at fitting.
7. Oil cooler line connector fittings at block (diesel only).



Clean

- All components in a suitable solvent and dry with compressed air.



Inspect

- All fittings, connectors, and cooler lines for damage or distortion.



Install or Connect (Figures 39 through 47)

NOTICE: For steps 1, 3, and 4, refer to "Notice" on page 6B1-1.

- Using your thumb and forefinger, insert the connector clip into one of the three recesses in the connector (C in figure 47). With one end of the clip engaged in the connector slot, use your thumb and rotate the clip around the connector until it snaps into place (D and E in figure 47).

NOTICE: Make sure the connector clip engages all three slots in the connector. Failure to properly install the connector clip could cause the oil cooler line to come loose and cause damage to the engine.

1. Oil cooler lines to the oil cooler (gasoline engines). Diesel engines install fittings into the block and use teflon sealer GM P/N 1052080 on the threads of the oil cooler lines.



Tighten

- Oil cooler line fittings to 23 N.m (17 lbs. ft.).
- 2. Oil cooler lines to the clip or strap.

6B1-28 ENGINE COOLING

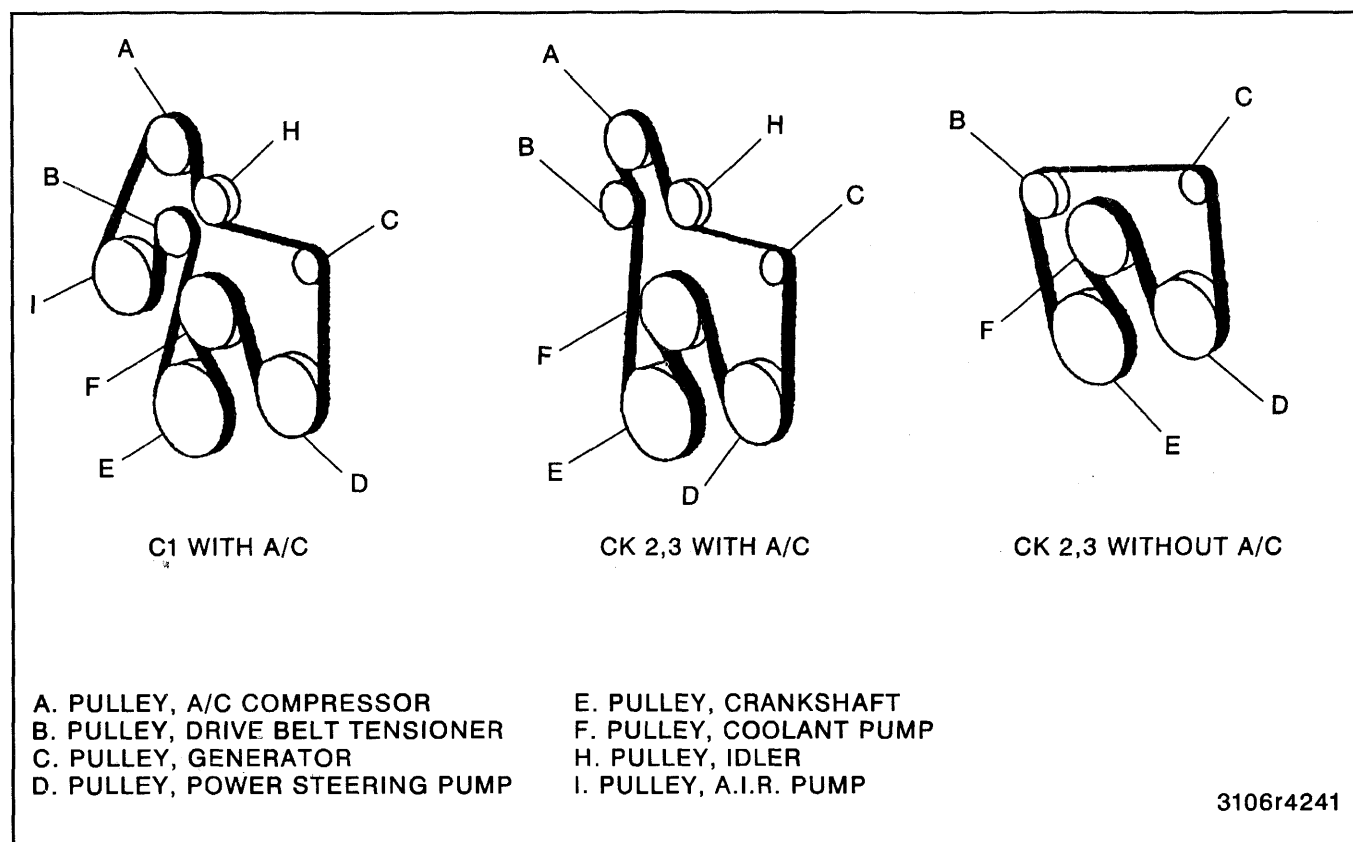


Figure 37—Multiple Rib Drive Belt Routing (C1, C/K 2,3 with 7.4L Engine)

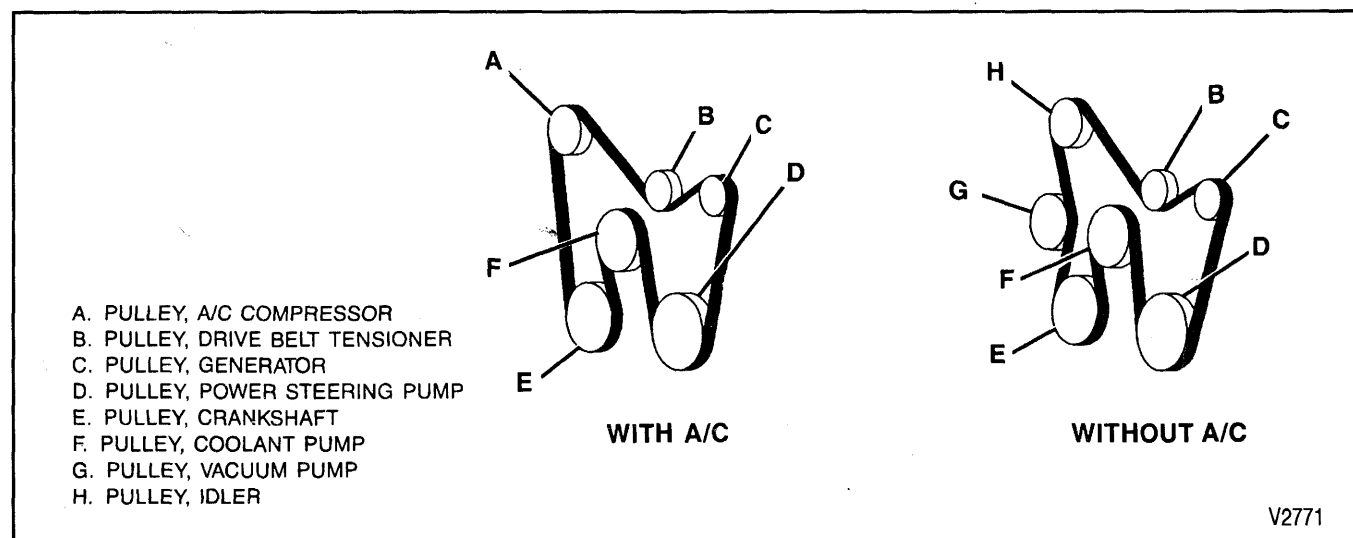


Figure 38—Multiple Rib Drive Belt Routing (Diesel Engines)

3. Bolt and clip to its bracket (diesel engines only) figure 44.



Tighten

- Bolt to 6 N.m (53 lbs. in.).

4. Bolt or nut to bracket or clamp.



Tighten

- Bolt to 9 N.m (80 lbs. in.).
- Nut to 13 N.m (115 lbs. in.).

5. New oil filter.

- Test the flow of oil through the cooler before connecting the lines.
- If the flow is not restricted, connect the oil lines to the connector.
- A distinct "snap" should be heard when assembling the oil cooler line to the quick connector. The oil cooler line must be fully inserted into the quick connector. Check this by applying a forceful pull to the fitting.

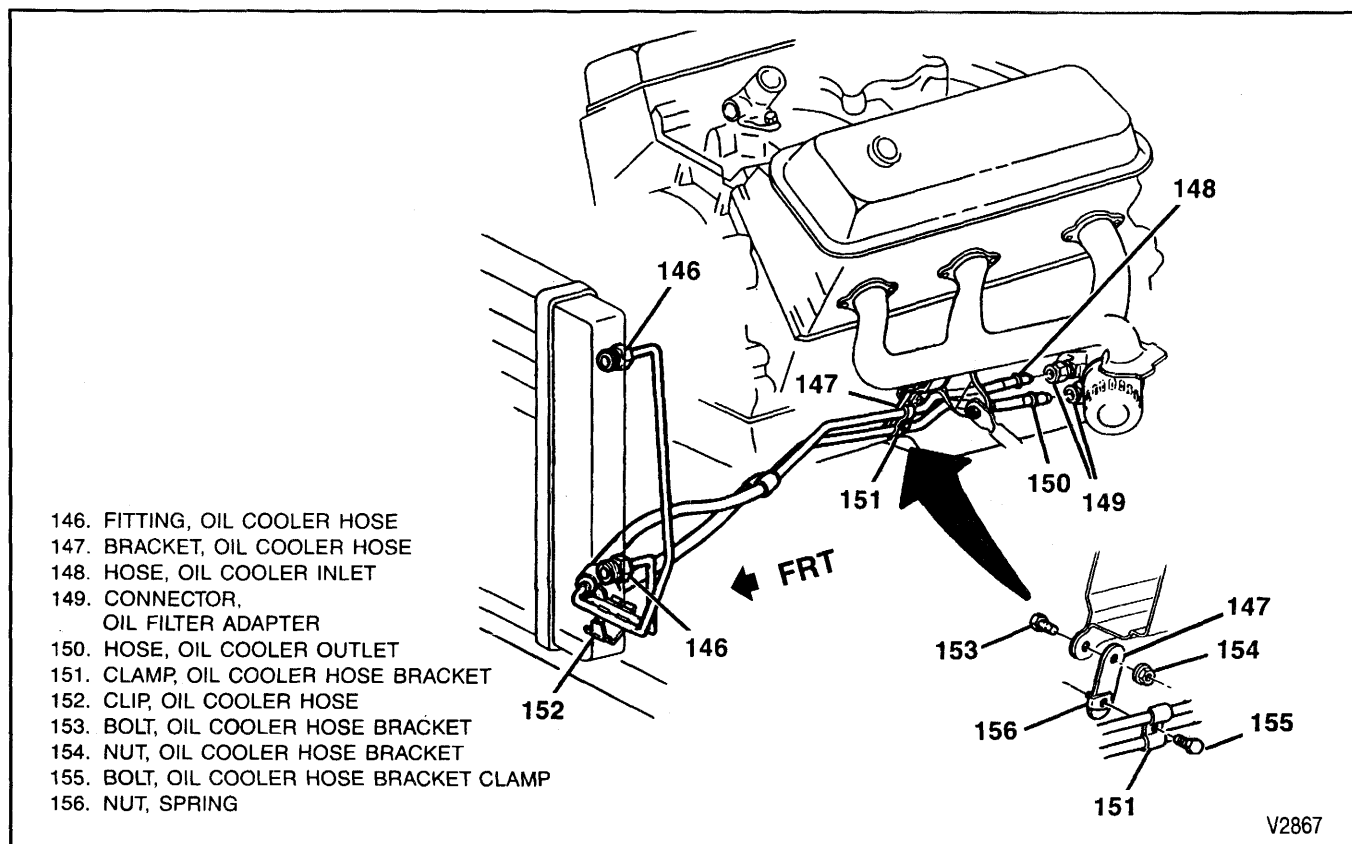


Figure 39—Engine Oil Cooler Lines and Components (4.3L Engine)

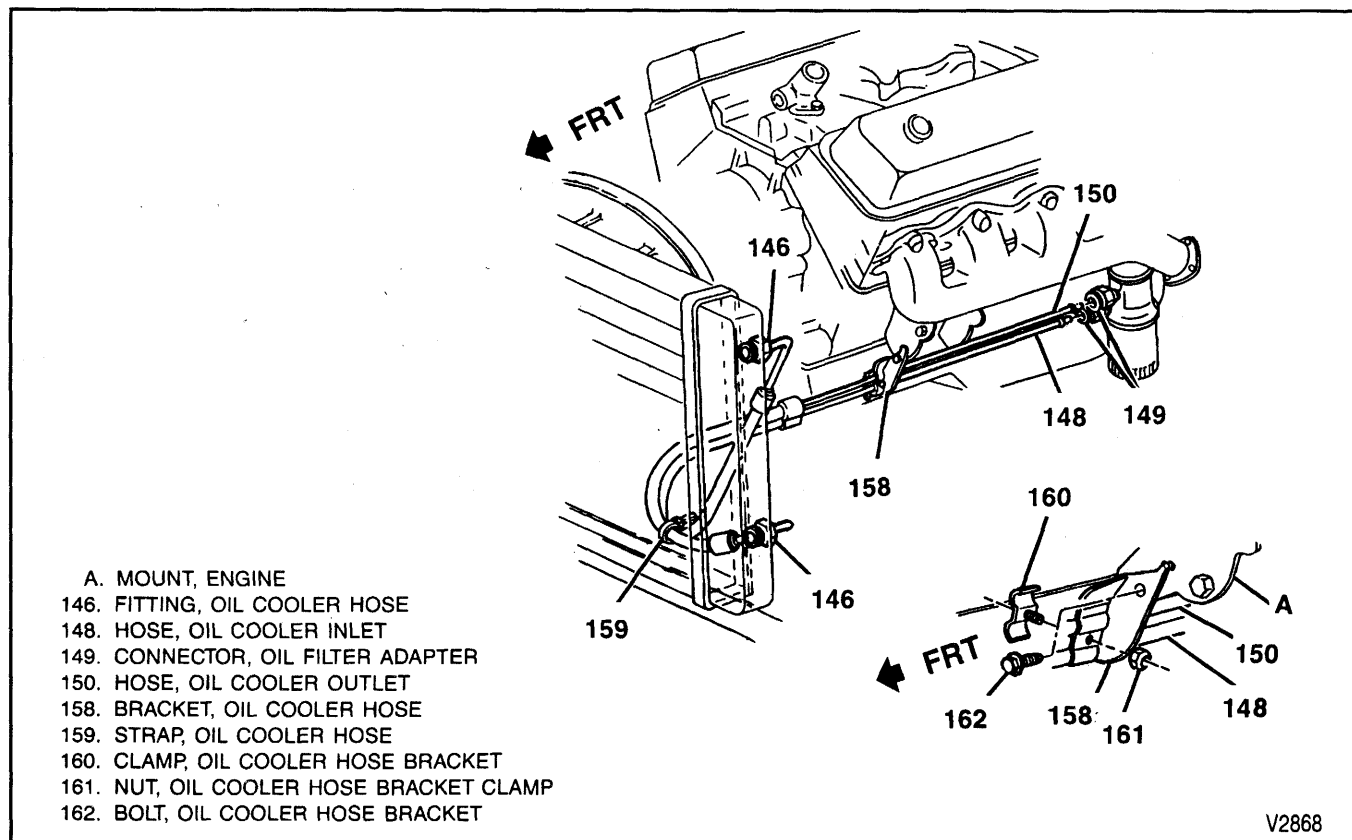


Figure 40—Engine Oil Cooler Lines and Components (5.0/5.7L Engines without H.D. Cooling)

6B1-30 ENGINE COOLING

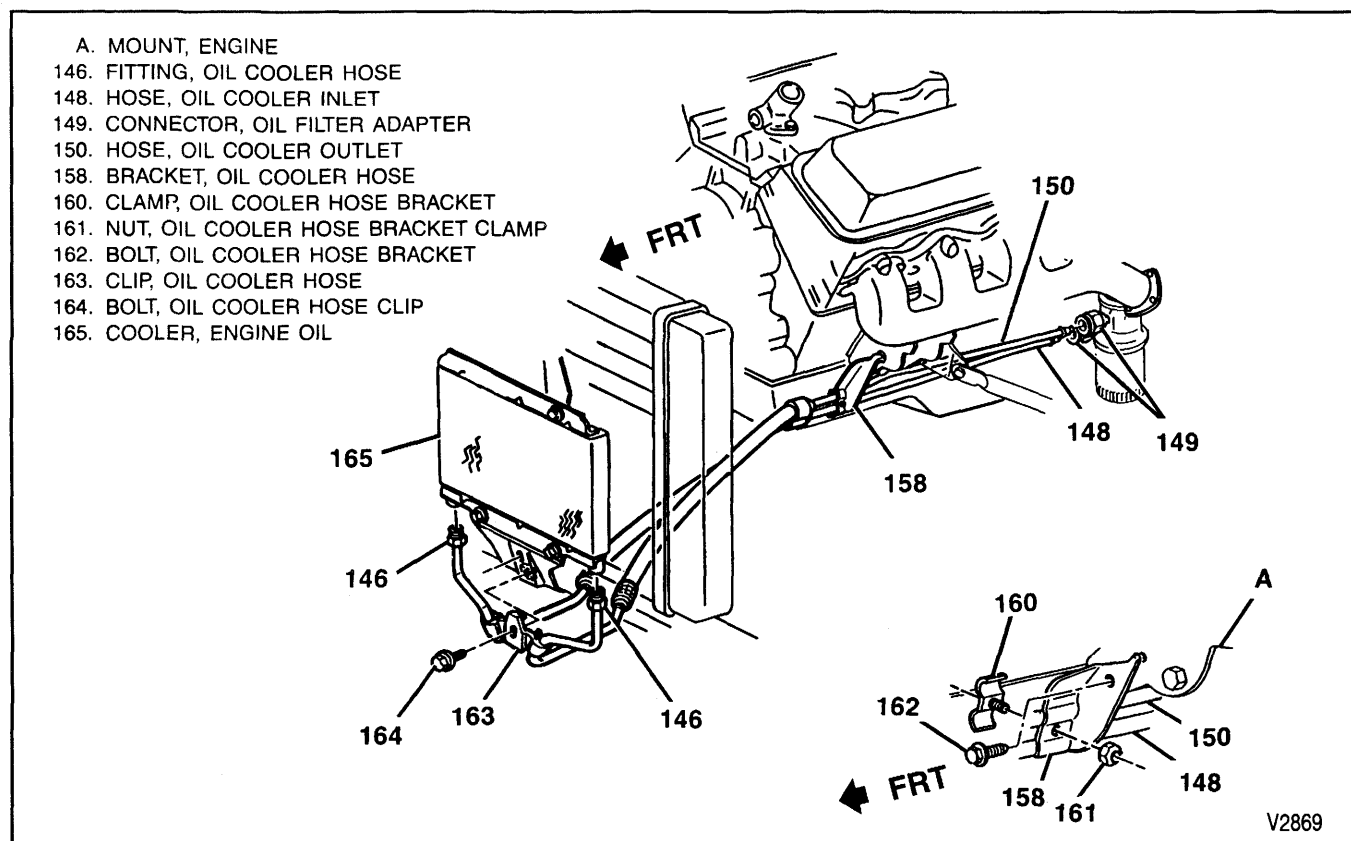


Figure 41—Engine Oil Cooler Lines and Components (5.7L Engine with H.D. Cooling)

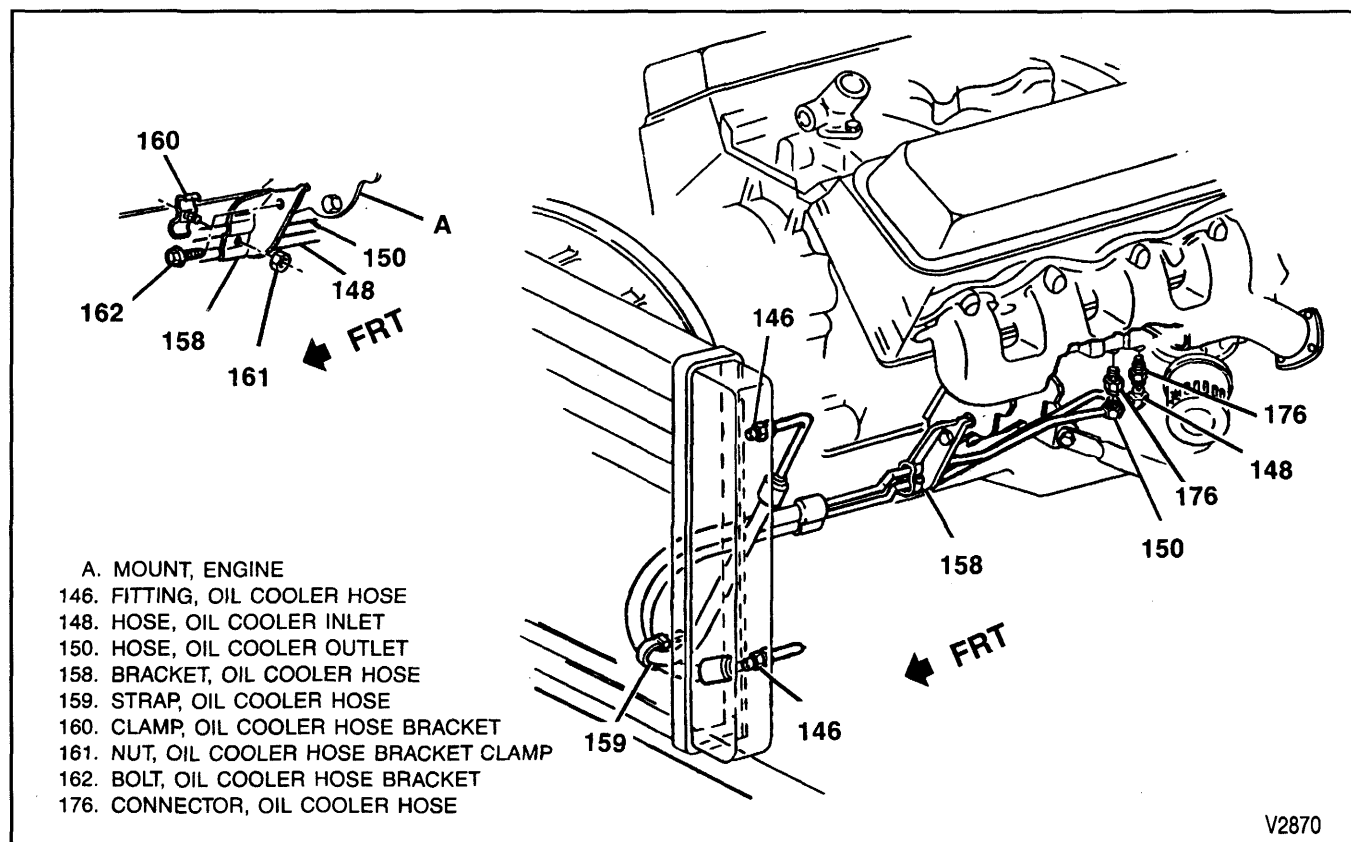
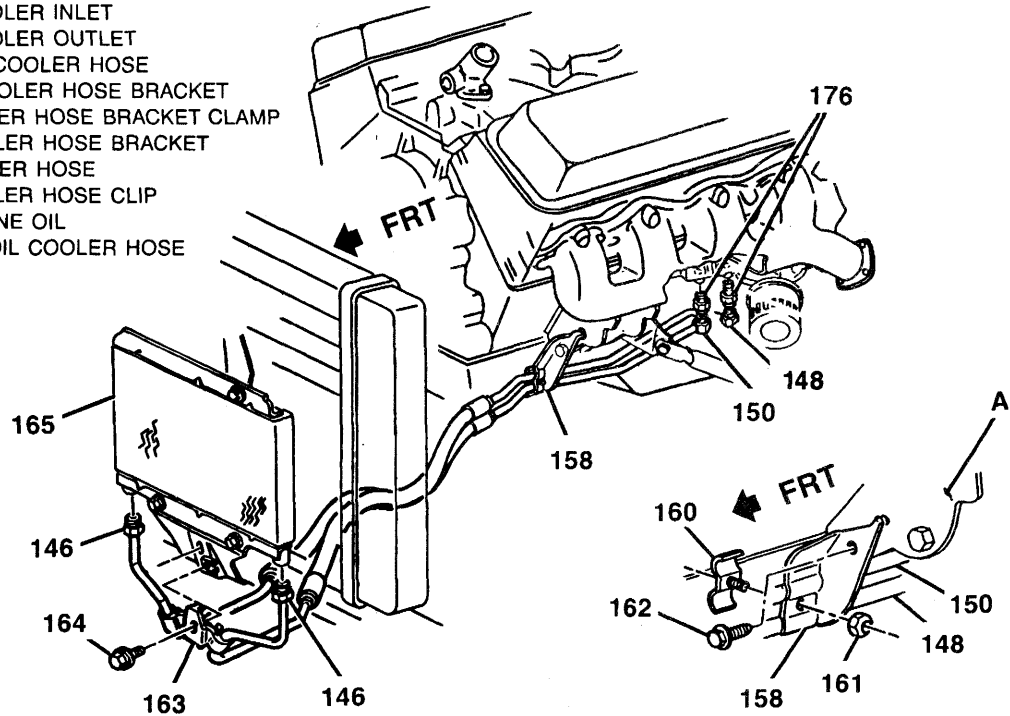


Figure 42—Engine Oil Cooler Lines and Components (7.4L Engine without H.D. Cooling)

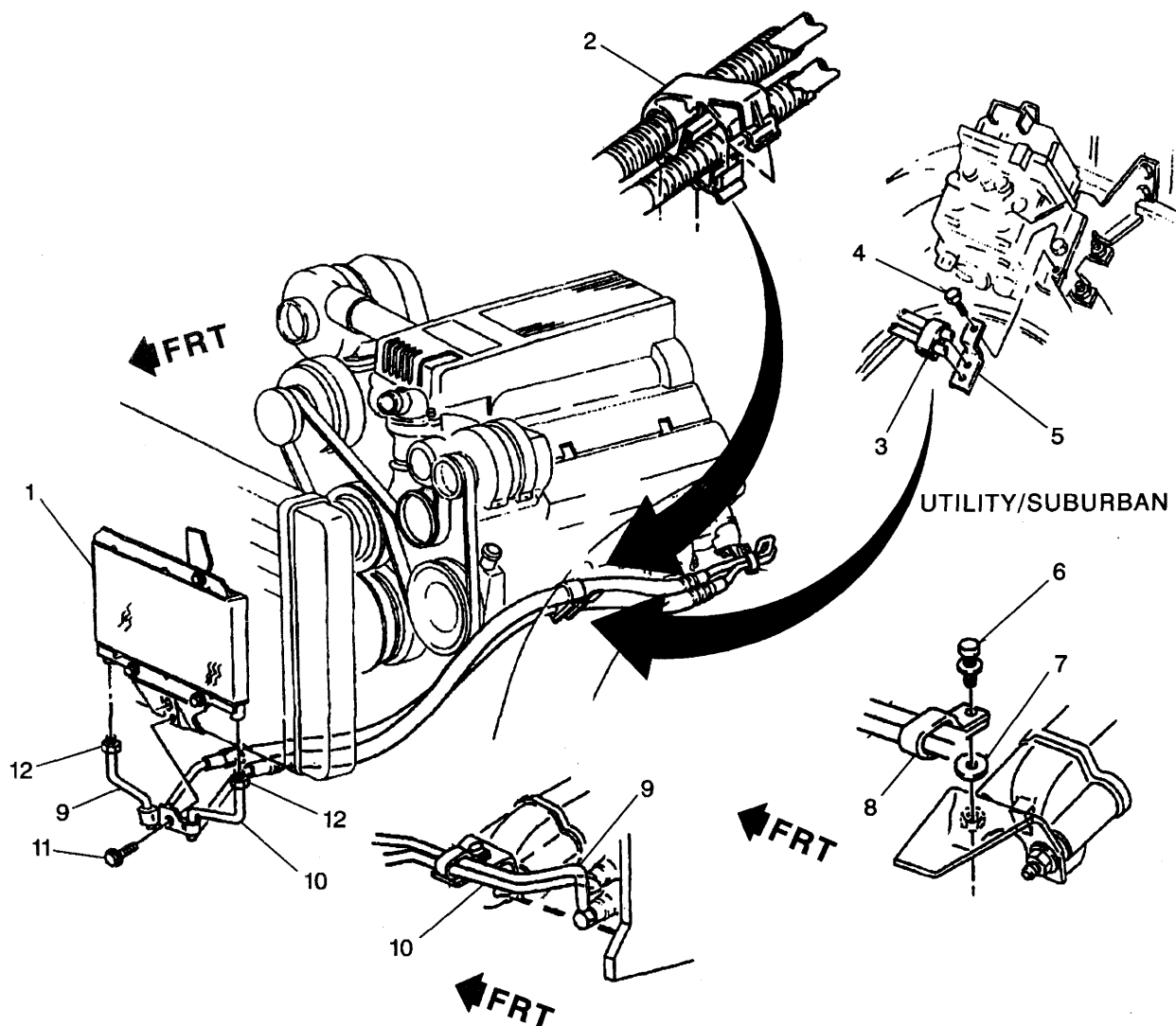
- A. MOUNT, ENGINE
- 146. FITTING, OIL COOLER HOSE
- 148. HOSE, OIL COOLER INLET
- 150. HOSE, OIL COOLER OUTLET
- 158. BRACKET, OIL COOLER HOSE
- 160. CLAMP, OIL COOLER HOSE BRACKET
- 161. NUT, OIL COOLER HOSE BRACKET CLAMP
- 162. BOLT, OIL COOLER HOSE BRACKET
- 163. CLIP, OIL COOLER HOSE
- 164. BOLT, OIL COOLER HOSE CLIP
- 165. COOLER, ENGINE OIL
- 176. CONNECTOR, OIL COOLER HOSE



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Figure 43—Engine Oil Cooler Lines and Components (7.4L Engine with H.D. Cooling)

- If the flow is restricted, replace the radiator.
Refer to SECTION 6B2.
- Run the engine and check for leaks.



1. COOLER, ENGINE OIL
2. CLIP
3. CLIP
4. BOLT
5. BRACKET
6. BOLT
7. WASHER
8. CLIP
9. HOSE, OUTLET
10. HOSE, INLET
11. BOLT, OIL COOLER HOSE CLIP
12. FITTING, OIL COOLER HOSE

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Figure 44—Engine Oil Cooler Lines and Components (Diesel)

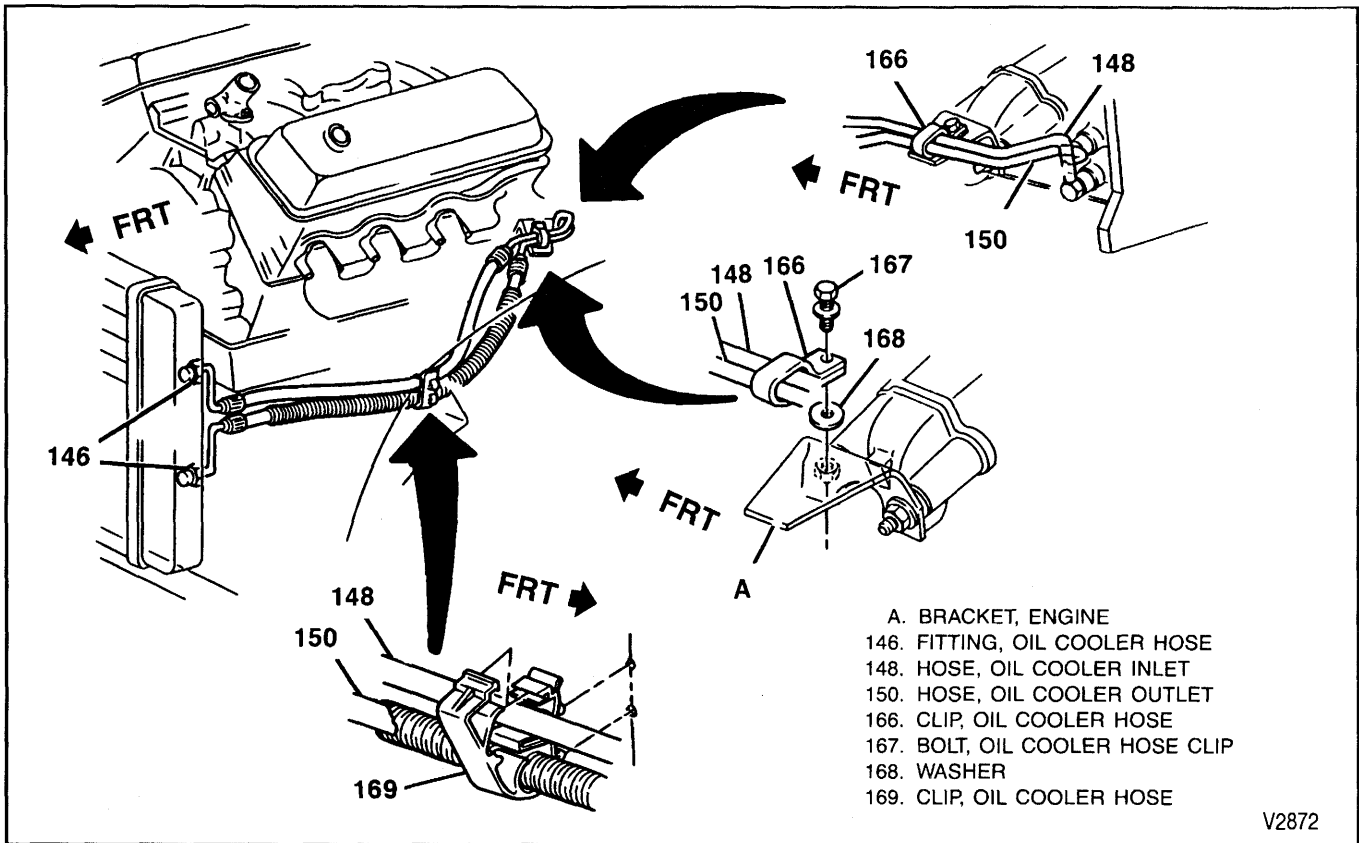


Figure 45—Engine Oil Cooler Lines and Components (Chassis Cab Diesel)

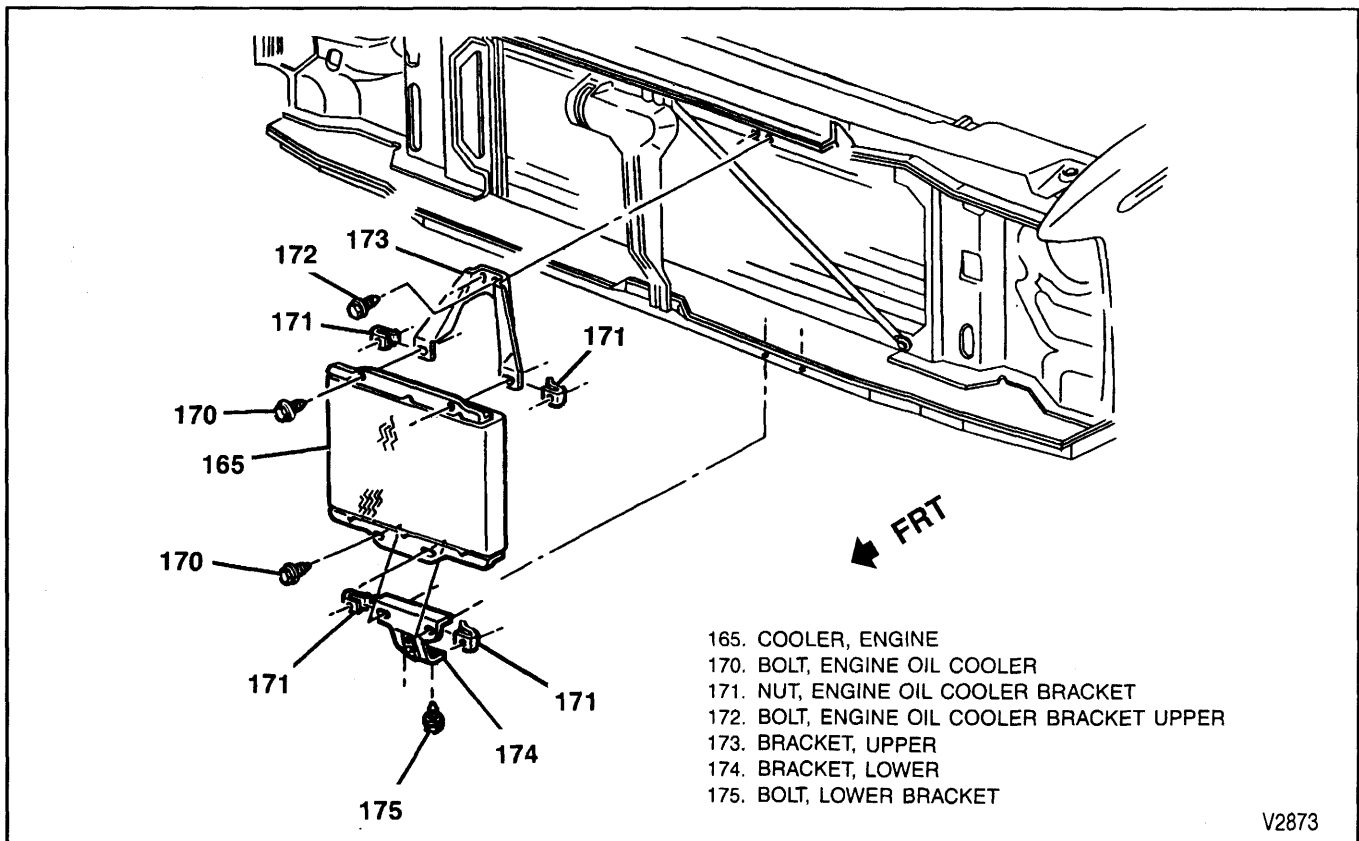


Figure 46—Auxiliary Engine Oil Cooler Assembly

6B1-34 ENGINE COOLING

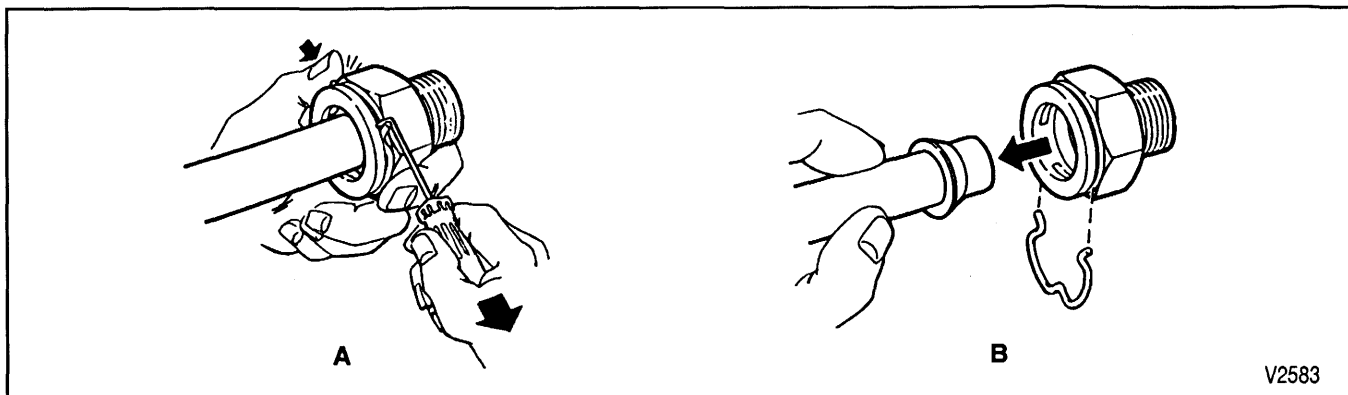


Figure 47—Removing Oil Cooler Line From Connector

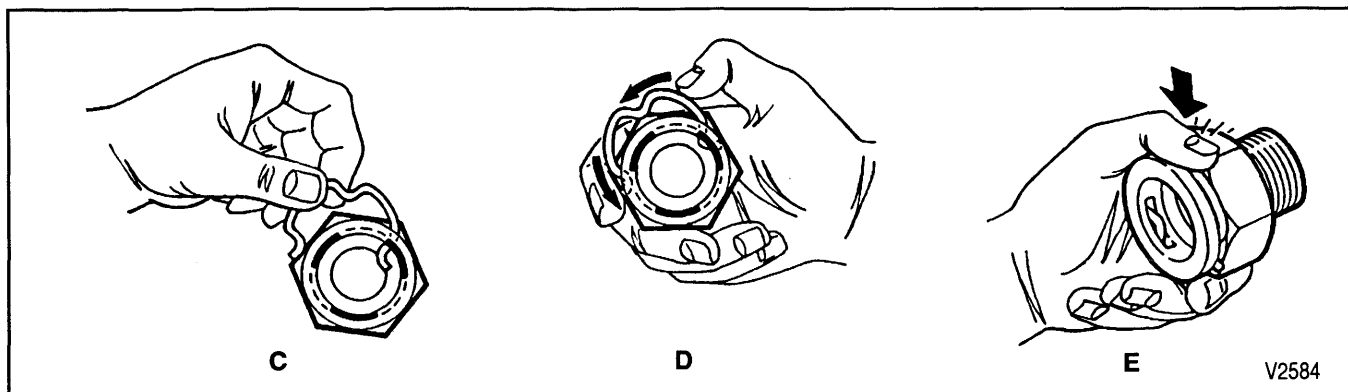


Figure 48—Installing Oil Cooler Line Clip Into Connector

SPECIFICATIONS

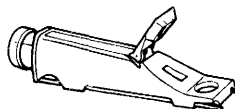
FASTENER TIGHTENING SPECIFICATIONS

Item	N-m	Ft. Lbs.	In. Lbs.
Coolant Crossover Housing to Cylinder Head Bolt (45) or Stud (44) (Diesel Engines)	42	31	—
Coolant Outlet to Crossover Housing Bolt (24) or Stud (22) (Diesel Engines)	42	31	—
Coolant Outlet to Intake Manifold Bolt (24) or Stud (20) (4.3L, 5.0L, and 5.7 Engines)	28	21	—
Coolant Outlet to Intake Manifold Stud (20) (7.4L Engines)	37	27	—
Coolant Pump Bolts (92) (Gasoline Engines)	41	30	—
Coolant Pump Plate to Block Bolts (96) (Diesel Engines)	23	17	—
Coolant Pump Plate to Block Studs (97) (Diesel Engines)	23	17	—
Coolant Pump Plate to Coolant Pump Bolt (98) (Diesel Engines)	23	17	—
Coolant Pump to Block Bolts (90) (Diesel Engines)	23	17	—
Coolant Pump to Block Bolts (92) (Diesel Engines)	42	31	—
Coolant Pump to Block Stud (93) (Diesel Engines)	42	31	—
Coolant Recovery Reservoir Bolts (102)	10	—	89
Coolant Temperature Sensor (145)	23	17	—
Drive Belt Tensioner Bolt (111) (Gasoline Engines)	83	61	—
Drive Belt Tensioner Bolt Nut (120) (Diesel Engines)	49	36	—
Fan Clutch to Coolant Pump Stud (13)	8	—	71
Fan Clutch to Coolant Pump Stud Nuts (17)	24	18	—
Fan to Fan Clutch Bolts (14)	24	18	—
Oil Cooler Line Bracket Bolt (155)	9	—	80
Oil Cooler Line Clamp Nut (161)	13	—	115
Oil Cooler Line Clip Bolt (167)	6	—	53
Oil Cooler Line Fittings (146)	24	18	—
Radiator Hose Clamps (52) (Diesel Engines)	3	—	27
Radiator Inlet Hose Support Bolt (55) (5.7L and 7.4L Engines)	3	—	27
Radiator Inlet Hose Support Bolt (59) (Diesel Engines)	9	—	80

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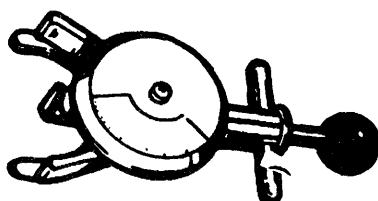
SPECIAL TOOLS

1.



J 23688 (FARENHEIT SCALE)
J 26568 (CENTIGRADE SCALE)

2.



BT-33-97 M
(MULTIPLE RIBBED BELT)

- 1. COOLANT TESTERS
- 2. BELT TENSION GAGE

SECTION 6B2

RADIATOR

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

RADIATOR

C/K radiators are crossflow, tube and center type, using an aluminum core with plastic side tanks. The core and side tanks can be replaced separately. Core repair is easily made with the hot melt adhesive method.

All radiators are fitted with a shroud designed to assist the fan in directing air flow through the radiator core and also serve as a fan guard. Provision for coolant expansion is achieved with a coolant recovery tank. This retards coolant overflow and reduces frequent refills.

Pressure is maintained in the radiator and system by a pressure cap. The pressure cap has two valves; one relieves pressure and the other compensates for coolant contraction when the engine is stopped. Radiator caps are provided in 103 kPa (15 psi) rating.

Radiators used with some automatic transmissions have transmission oil coolers built into the right tank, with inlet and outlet fittings for transmission fluid circulation.

In some applications there is an engine oil cooler available that is built into the left tank, with inlet and outlet fittings for engine oil circulation.

RADIATOR CAP

A pressure-vent cap allows a buildup of 103 kPa (15 psi) in the cooling system. This pressure raises the boiling point of the coolant to about 125°C (257°F) at sea level. Do not remove the radiator cap to check the engine coolant level; check the coolant visually at the see-through coolant reservoir. Add coolant to the reservoir when the system cools.

CAUTION: As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the radiator cap while the engine is hot and the pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders, and person removing the cap. If the solution contains flammable anti-freeze such as alcohol (not recommended for use at any time), there is also the possibility of causing a serious fire.

The pressure-type radiator filler cap contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring of pre-determined strength, which protects the radiator by relieving internal pressure when it exceeds cooling system design limits. The vacuum valve is held against its seat by a light spring which permits opening of the valve to relieve vacuum created in the system when it cools off and which otherwise might cause the radiator to collapse (figure 1).

The radiator cap is designed to discourage inadvertent removal. To safely remove the cap, rotate the cap

slowly to the left, without pressing down, to the detent (figure 2). Allow any pressure to relieve. Next, press down on the cap and continue to rotate the cap to the left and lift off the cap.

Under the diaphragm spring at the top of the cap is a gasket. Embossed on the cap is a caution against its being opened and arrows indicating the proper closed position (figure 3).

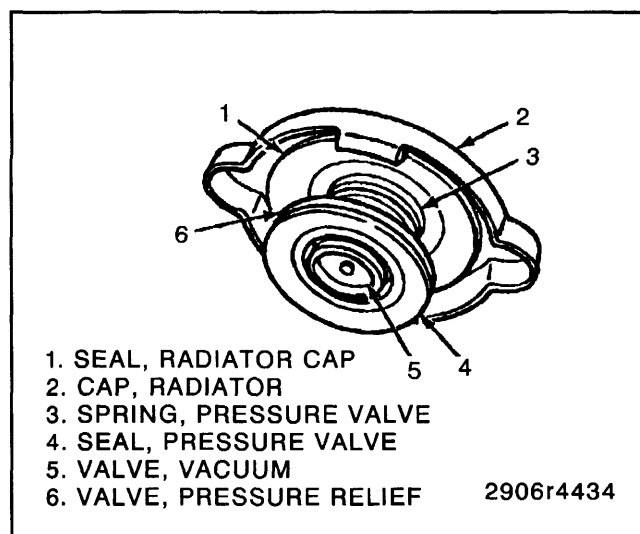


Figure 1—Radiator Cap Pressure and Vacuum Valves

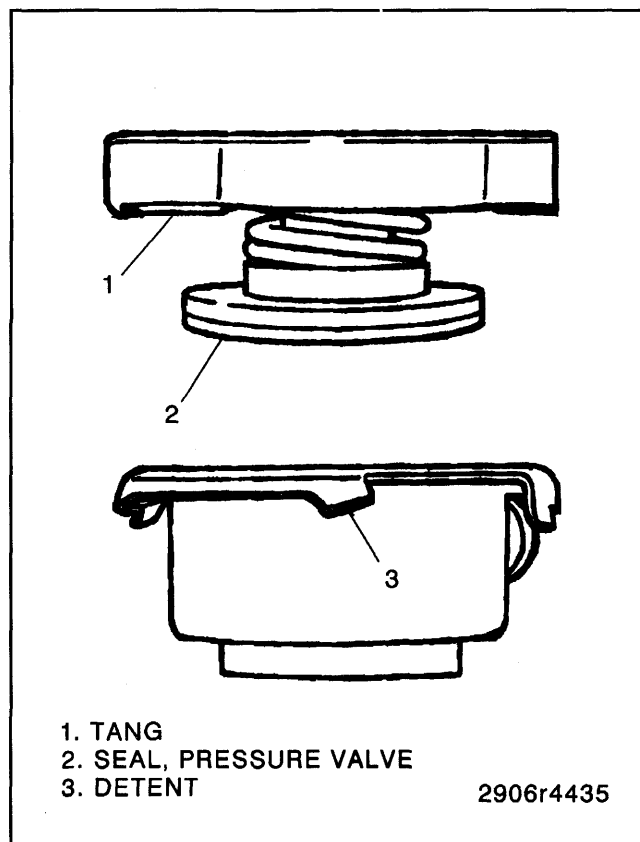
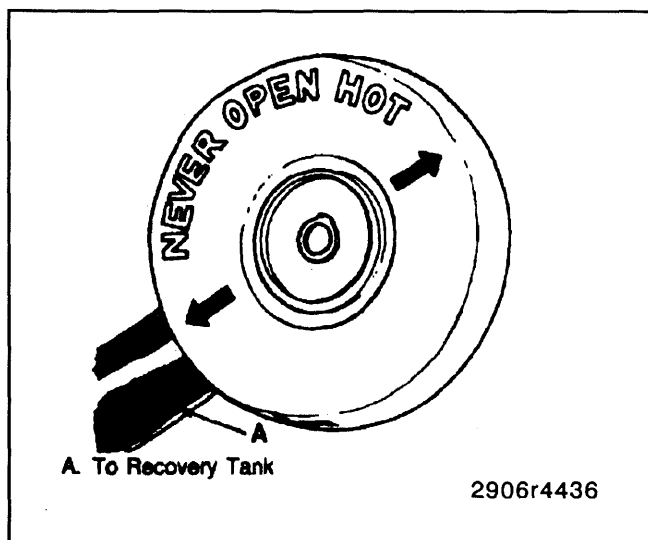
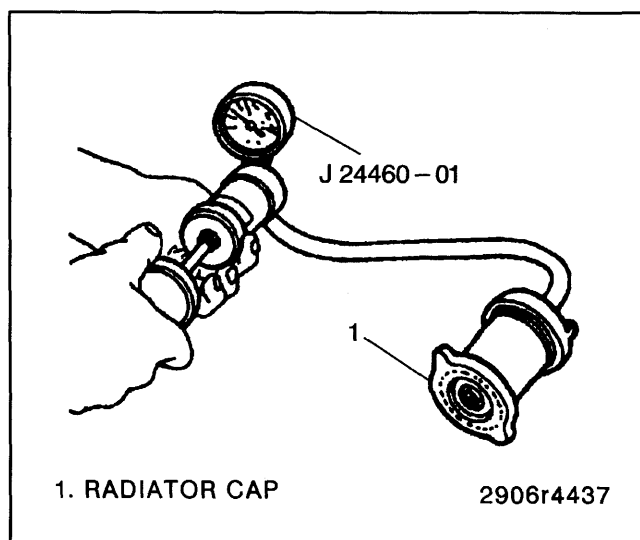


Figure 2—Radiator Cap and Filler Neck


Figure 3—Radiator Cap Alignment Arrows

The seal of the filler cap and the operation of the pressure relief valve can be checked using a conventional cooling system testing kit such as J 24460-01 (figure 4).


Figure 4—Testing the Radiator Pressure Cap

DIAGNOSIS OF RADIATOR

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Overheats	1. Cooling area obstructed. 2. Radiator fins plugged. 3. Leaking radiator. 4. Bent fins.	1. Remove or relocate added on parts that may block air to the radiator. 2. Remove any debris (bugs, leaves, etc.) from the radiator fins. 3. Repair leaks or replace seals. 4. Repair or replace.
Radiator Loose	1. Loose screws. 2. Missing insulators.	1. Tighten screws. 2. Replace insulators.

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MAINTENANCE RECOMMENDATIONS

Check the outside of the radiator for bent fins or signs of leakage. Repair leaking radiator cores.

Do not seal temporarily with a sealer type antifreeze or coolant additive. Remove any stones between the fins. Clean loose debris and road film from the radiator core with a quality grease solvent and compressed air.

Remove the grille, and fan shroud, to ensure a thorough cleaning.

Remove the radiator cap and look for plugging and scale on the inside of the tank. Replace a badly plugged radiator. Test the radiator and system as described in SECTION 6B1.

1. Check the coolant level. If low, add recommended coolant as required.
2. Check the hose conditions and tighten the clamps if leakage is evident. Replace cracked, stripped, or corroded clamps.
3. Check the coolant hoses for spongy or cracked appearance. Replace deteriorated hoses or burst-

ing could occur, which would result in coolant loss and extensive damage due to overheating.

4. Check the radiator core for leaks and for accumulation of dirt which may obstruct the air passages and reduce heat transfer.
5. Check the recovery tank for leaks. Plastic bottles may develop cracks from being damaged by flying objects.
6. Inspect the radiator rubber mountings and bumpers for deterioration and replace as necessary. Check the mounting bolts, supports, braces, tie rods, and stabilizer rods. Components should be securely fastened in place if mounting bolts are missing, loose, or stripped. Check for damage to the core, side flanges, and supporting components.
7. Check for clearance between the fan blades, core, and shroud. Make sure the fan attaching bolts are tight and that none are missing. Replace the fan if any blade is bent.

6B2-4 RADIATOR

8. Inspect the filler cap for evidence of cracking, separation, or deterioration. Replace as required.
9. An occasional external flushing with water will remove the majority of dirt accumulation and foreign matter from between the core fins and will help to maintain efficient heat dissipation. Direct water under moderate pressure from behind the core to force debris out in the opposite direction of its entry. Remove the grille and fan shroud and direct the water stream in line with the fins to reduce the possibility of bending fins.

RADIATOR INTERNAL DEPOSITS

A radiator with a dirty, obstructed, or leaking core will cause the engine to overheat. A scale deposit inside the radiator is a result of using hard, high mineral content water in the cooling system. The effect of heat on the minerals in the water causes the formation of scale, or hard coating, on metal surfaces within the radiator, thereby reducing the transfer of heat. Some hard water will produce a silt-like deposit which restricts the flow of water. Replace a radiator that is plugged or has a heavy scale on the core.

SCALE REMOVAL

To remove the hardened scale, a direct chemical action is necessary. A flushing compound at the speci-

fied rate of 30 grams per liter (4 oz. per gallon) of radiator capacity should be added to the coolant solution in the form of a dissolved solution while the engine is running. Operate the engine for 15 minutes or until it reaches normal operating temperature, then drain and flush the system with clean water.

There are various types of flushing compounds commercially available, but they should be obtained from a reliable source. Most compounds attack metals and should not remain in the engine for more than a few minutes. A neutralizer should be used in the cooling system immediately after a descaling solvent is used.

For extremely hard, stubborn coatings, such as lime scale, use a stronger solution. The corrosive action of a stronger solution will affect the thin metals of the radiator, thereby reducing its operating life. A complete flushing and rinsing is mandatory and must be accomplished skillfully.

After the solvent and neutralizer have been used and the cooling system is flushed, drain the entire system and fill it with clean, soft water plus a high boiling type antifreeze that meets GM 6038-M specifications. After filling the cooling system, check for radiator, hose, and engine coolant leaks.

ON-VEHICLE SERVICE

DRAIN COCK

CAUTION: To help avoid the danger of being burned, do not remove the radiator cap or diesel surge tank cap while the engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if the cap is taken off too soon. Remove the radiator cap before draining the coolant, so the coolant is not forced out under pressure.

↔ Remove or Disconnect (Figure 5)

- Drain radiator of coolant.
1. Drain cock stem (A).
 - Seal (B) will usually come out attached to stem (A).
 2. Drain cock body (C).
 - Squeeze sides of body with fingers or needlenose pliers to disengage body locking tangs from side tank.

→ Install or Connect (Figure 5)

1. Drain cock body (C).
 - Be sure body is fully seated in side tank and that locking tangs are engaged.
2. Seal (B) to stem (A).
3. Stem (A) into body (C). Turn lock in place.
 - Add proper coolant as specified in SECTION 0B.
 - Start engine and check for leaks.

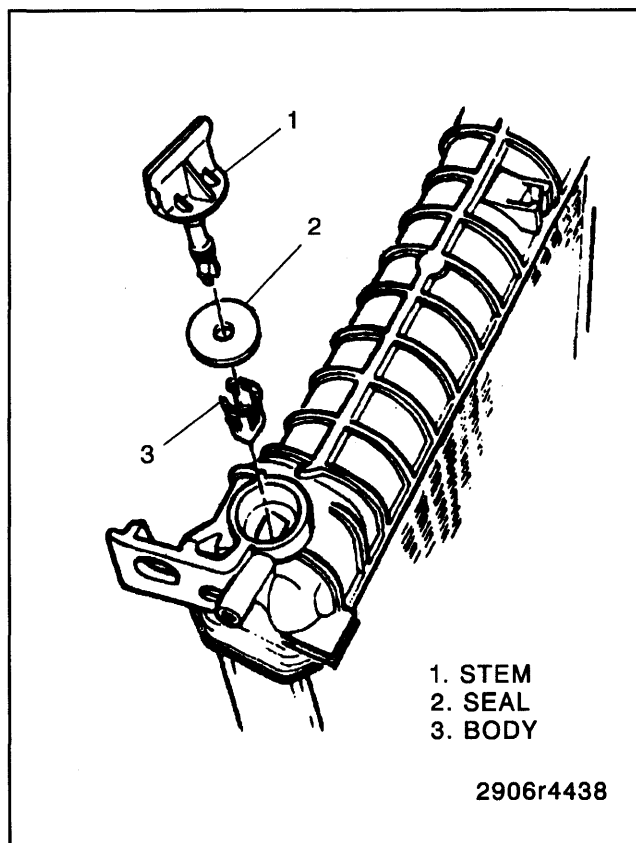


Figure 5—Radiator Drain Cock

FAN SHROUD REPLACEMENT

UPPER FAN SHROUD

Remove or Disconnect (Figures 6 through 8)

1. Upper radiator hose from the radiator.
2. Upper shroud bolts and upper shroud.

Inspect

- Upper shroud for signs of damage. Replace if necessary.

Install or Connect (Figures 6 through 8)

1. Upper shroud and upper shroud bolts.

NOTICE: Refer to "Notice" on page 6B2-1.

Tighten

- Bolts (4) to 9 N.m (71 lbs. in.).
2. Upper radiator hose to the radiator.

LOWER FAN SHROUD

Remove or Disconnect (Figures 6 through 8)

1. Upper shroud (1), as outlined previously.
 - Raise the vehicle.
2. Lower shroud bolts (4) and lower shroud (2).

Inspect

- Lower shroud for signs of damage. Replace if necessary.

Install or Connect (Figures 6 through 8)

1. Lower shroud (2) and bolts (4).

NOTICE: Refer to "Notice" on page 6B2-1.

Tighten

- Bolts (4) to 9 N.m (71 lbs. in.).
 - Lower the vehicle.
2. Upper shroud (1), as outlined previously.

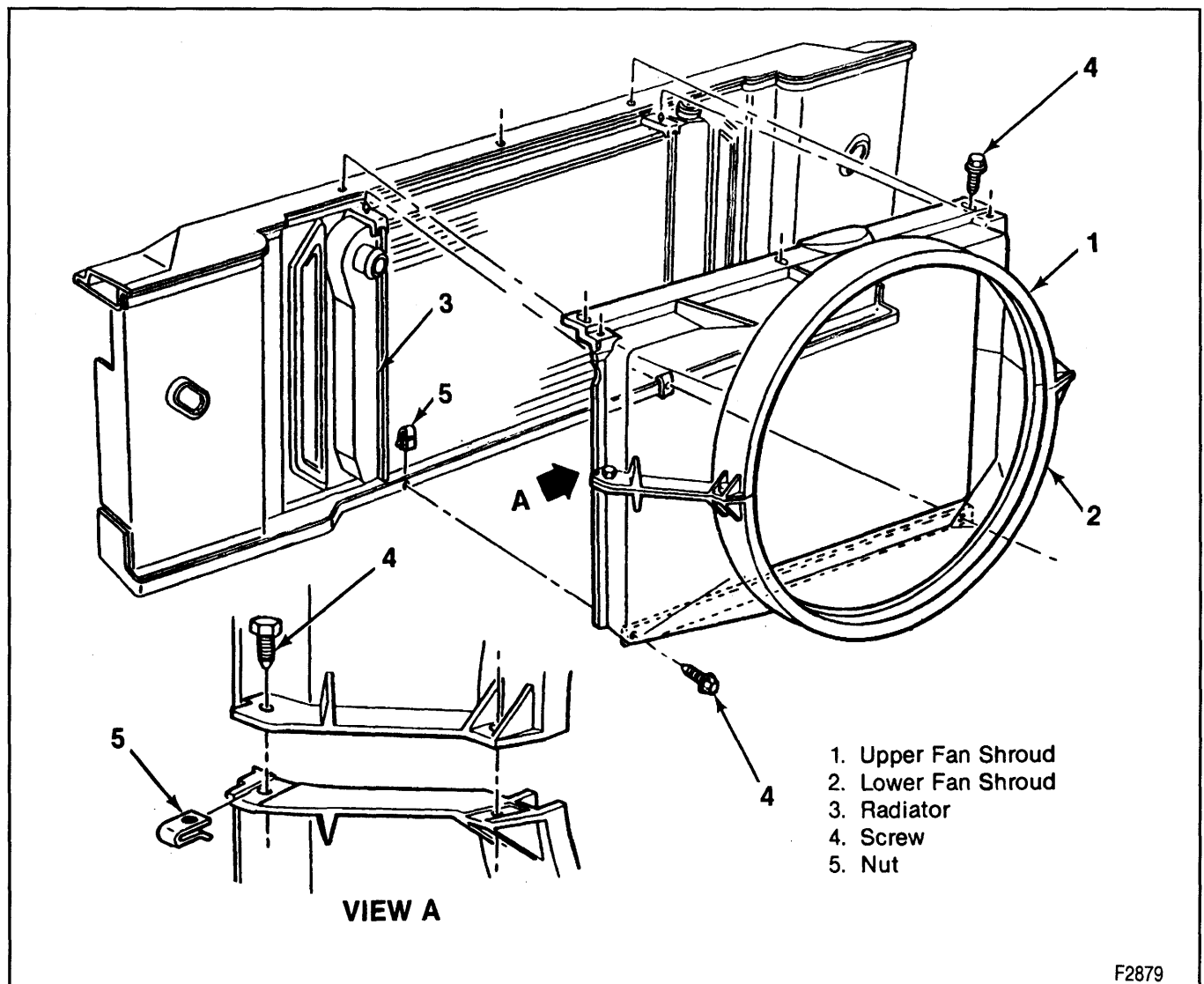


Figure 6—Fan Shroud and Components (4.3L, 5.0L and 5.7L Engines)

6B2-6 RADIATOR

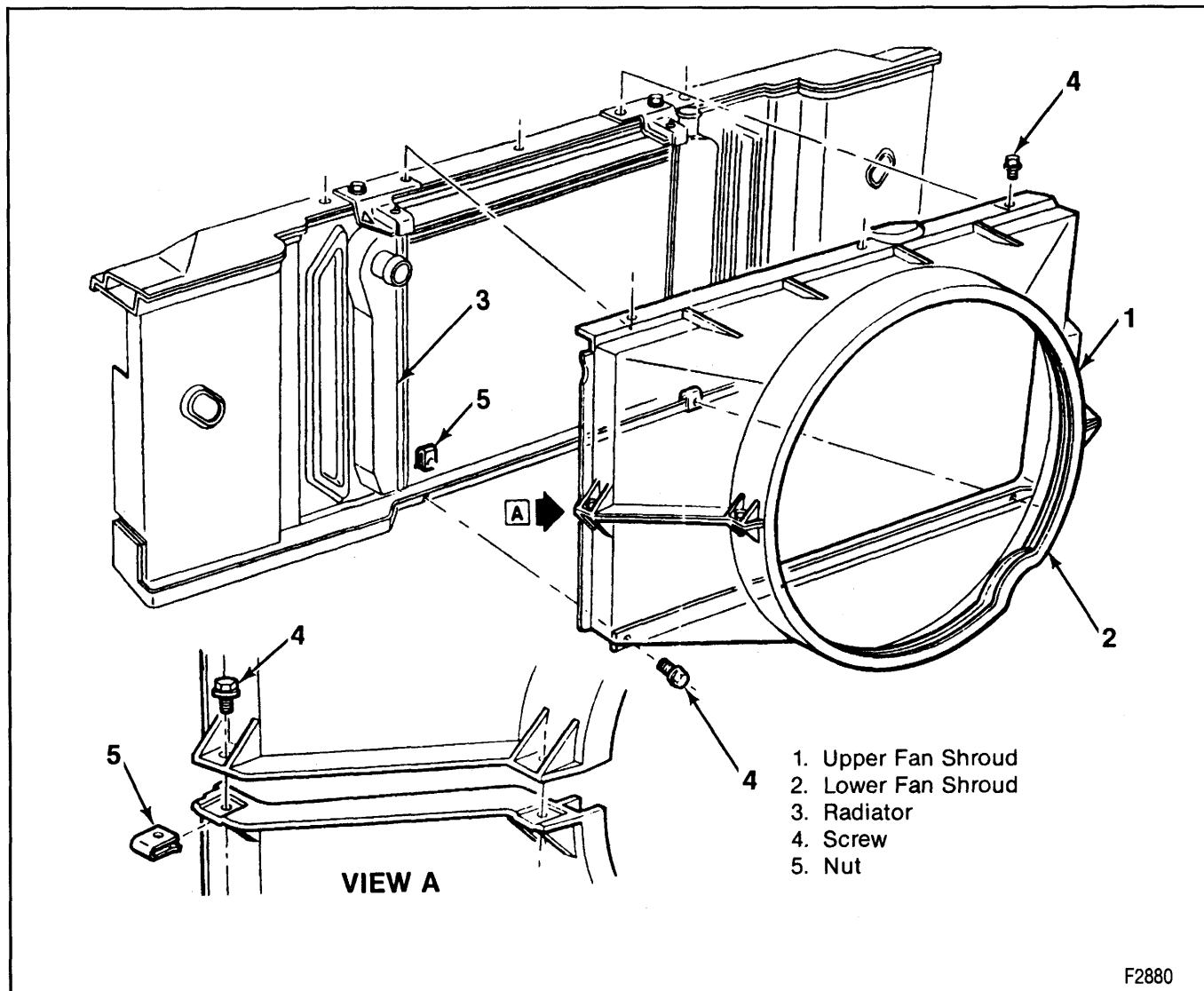


Figure 7—Fan Shroud and Components (7.4L, 6.5L Diesel and some 5.7L applications)

RADIATOR REPLACEMENT

Install or Connect (Figures 6 through 8)

Remove or Disconnect (Figures 6 through 8)

1. Coolant from the radiator.
2. Upper fan shroud bolts and upper fan shroud.
3. Upper insulators.
4. Upper and lower radiator hoses.
5. Transmission fluid cooler pipes.
6. Engine oil cooler pipes.
7. Lower fan shroud bolts and lower fan shroud.
8. Overflow hose.
9. Radiator from the lower insulators.

Inspect

- All parts and connections for leaks and wear. Replace if necessary.

NOTICE: For steps 3, 4, 5, and 8, refer to "Notice" on page 6B2-1.

1. Radiator on the lower insulators.
2. Overflow hose.
3. Lower fan shroud bolts and lower fan shroud.

Tighten

- Bolts to 9 N.m (71 lbs. in.).

4. Engine oil cooler pipes.

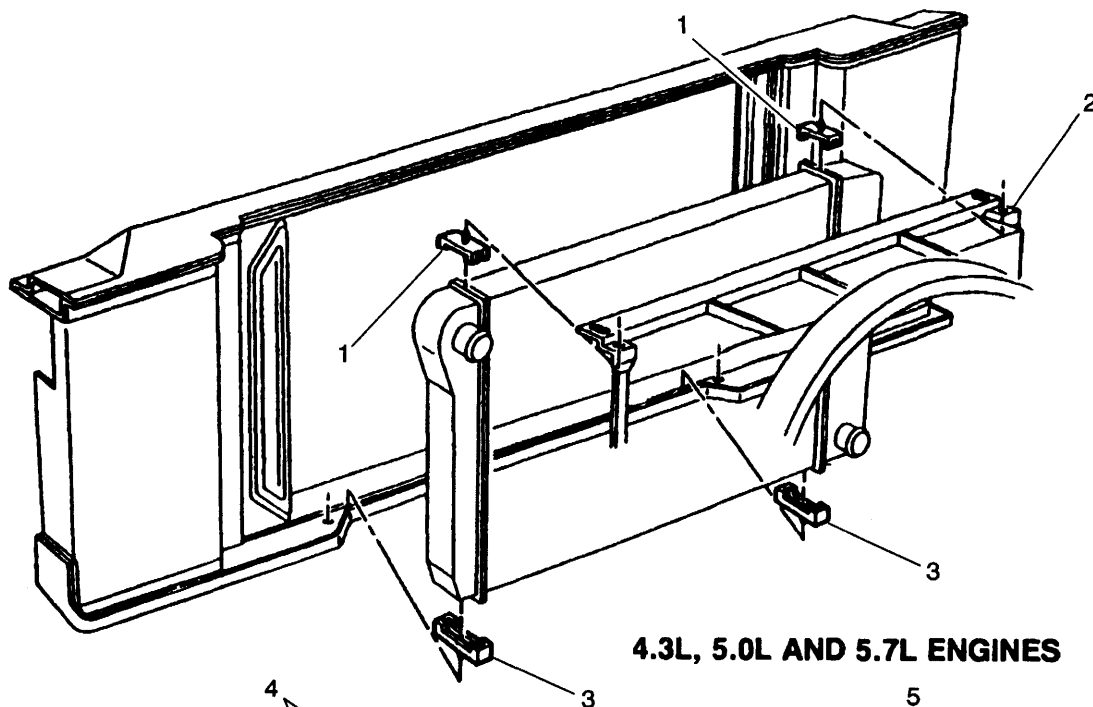
Tighten

- Fittings to 24 N.m (18 lbs. ft.).

5. Transmission fluid cooler pipes.

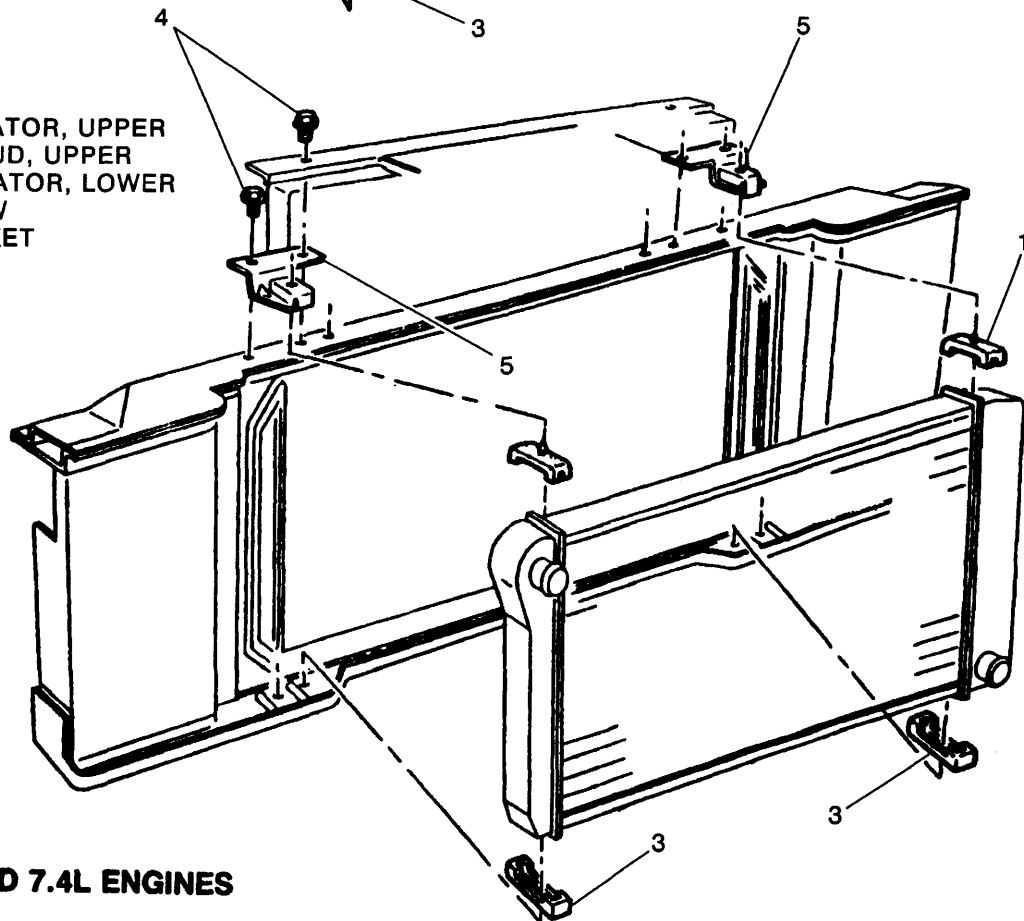
Tighten

- Fittings to 26 N.m (19 lbs. ft.).



4.3L, 5.0L AND 5.7L ENGINES

- 1. INSULATOR, UPPER
- 2. SHROUD, UPPER
- 3. INSULATOR, LOWER
- 4. SCREW
- 5. BRACKET



6.5L AND 7.4L ENGINES

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Figure 8—Radiator Mounting Components

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6. Upper and lower radiator hoses.
7. Upper insulators (11).
8. Upper fan shroud (1) and fan shroud bolts (4).



Tighten

- Bolts to 9 N.m (71 lbs. in.).
9. Coolant in the radiator.
- Leak test.

RADIATOR SERVICE

TESTING PROCEDURES

LEAK TESTING

Some core leaks can be detected by adding water to the radiator. Clean the core so that the damaged area can be found. Refer to figure 9 for a radiator component view.

1. Remove dirt and insects from the fins with a common water hose without a nozzle. Excessive water pressure could damage the fins.
2. Scrub the core with a soft-bristle brush using clean, hot water, or hot water with a mild detergent.

ON-VEHICLE PRESSURE TESTING

Pressure-test the aluminum-plastic radiator with J 24460-01 Cooling System Tester (figure 10). With the system at a cool temperature, remove the radiator cap, connect the gage, and apply normal system operating pressure. Do not exceed 138 kPa (20 psi). Watch the gage needle for an indication of a leak, and examine the radiator and other cooling system parts for escaping coolant.

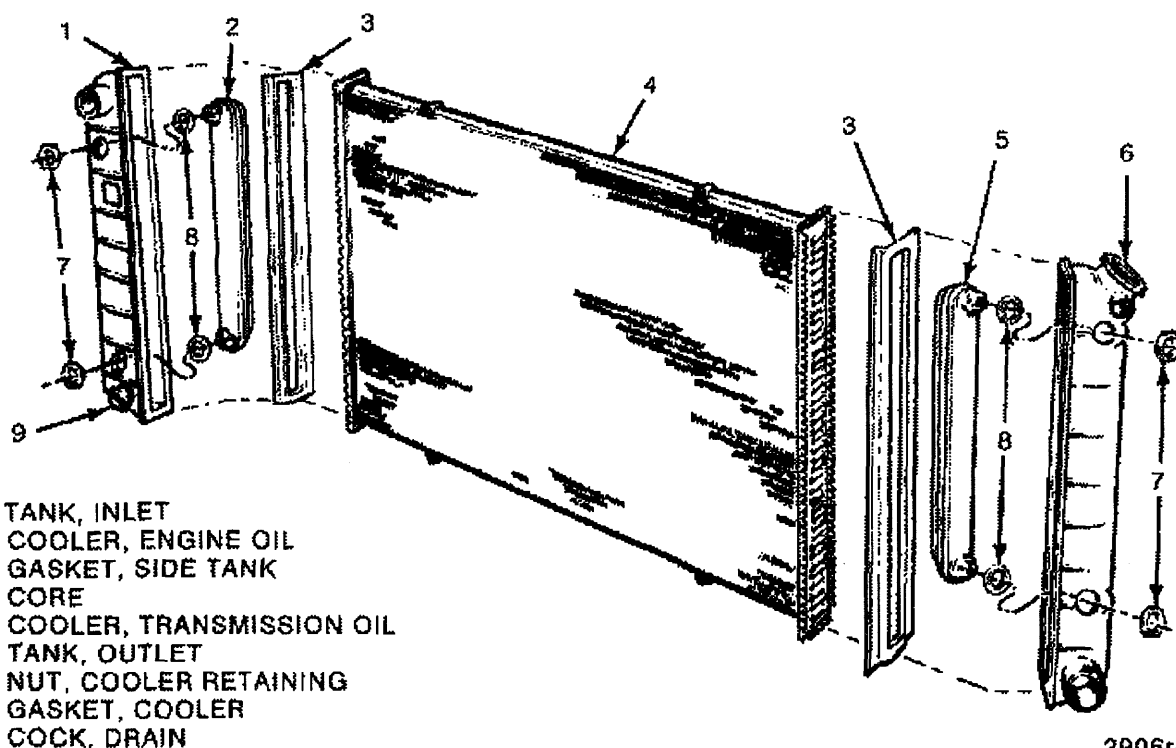
Repair hose and hose connections as required. Check the radiator cap to ensure that it will maintain the correct pressure.

If the radiator leaks during the pressure test, mark the leak area.

OFF-VEHICLE LEAK TESTING

NOTICE: Do not use boil-out tanks, vats, or other tanks that have been used for copper and brass radiators. The flux, acid, and caustic cleaners remaining in these tanks will attack the aluminum and cause radiator failure. Use a separate test tank containing clean water for servicing aluminum/plastic radiators.

1. Install test fittings or rubber test caps in the inlet and outlet necks and seal the oil cooler fittings with metal plugs to protect the cooler and keep the fluid from running out (figure 11).



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Figure 9—Radiator Components

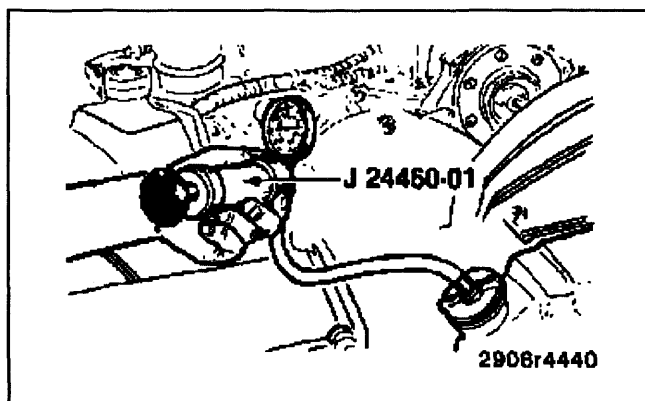


Figure 10—Pressure Testing

2. Attach the pressure tester and gradually apply air pressure until 138 kPa (20 psi) is attained. Do not exceed 138 kPa (20 psi). Check the pressure gage to see if there is a pressure loss. To ensure that there are no small leaks, run water over the repair area and look for bubbles. (A mild detergent is helpful). If a large water tank is available, submerge the radiator and check for air bubbles.

REPAIRABLE LEAKS

There are two types of leaks that can be repaired on the aluminum-plastic radiator: core leaks and gasket or seal leaks. Leaks in the plastic tanks cannot be repaired (figure 12).

Core leaks can occur in a tube or in the joints between the tubes and headers. Gasket leaks can occur in the joints between the plastic tanks and the headers or in the joints between the oil cooler fittings and the tank. Some leaks can be repaired while the radiator is on the vehicle; however, it is usually best to remove the radiator.

REPAIR METHODS

There are several methods that can be used to repair the radiator core, but the hot melt adhesive method repair kit is the most simple and effective.

The kit contains adhesive sticks, cotton swabs, a wire brush, and the primer. The adhesive stick is reusable, has an indefinite shelf life, and is waste-free. Store the sticks in a sealed container to keep them dry (figure 13).

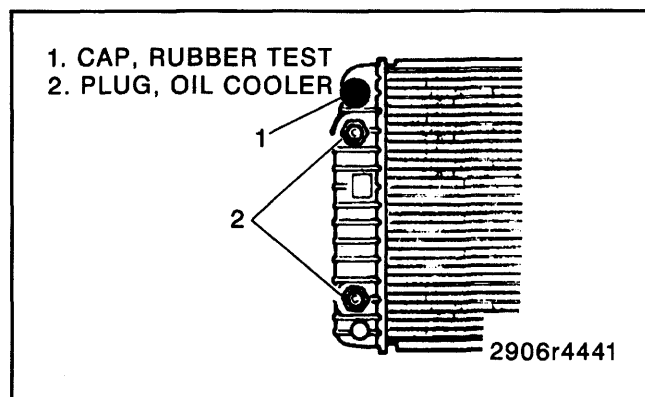


Figure 11—Oil Cooler Plugs

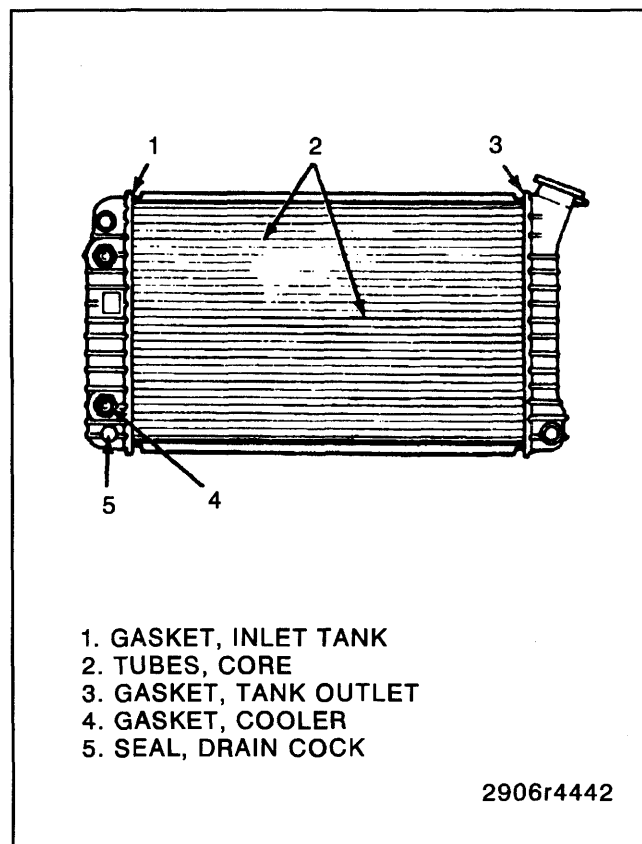


Figure 12—Possible Leak Areas

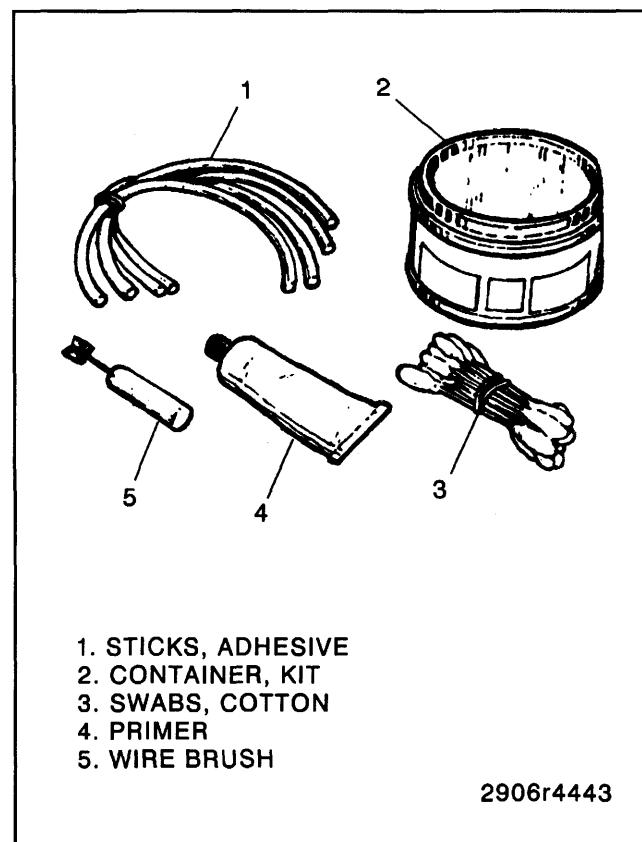


Figure 13—Hot Melt Repair Kit

RADIATOR REPAIR PROCEDURES

The aluminum-plastic radiator can be repaired. The following components can be replaced:

- Core
- Tanks and gaskets
- Oil coolers and gaskets
- Drain cock and gasket

The tanks cannot be repaired if broken or cracked. The radiator core can be replaced and the new core used with the original tanks and oil cooler.

PRECAUTIONS

As with all cooling system service, take measures to prevent personal injury and damage to the system.

CAUTION: To help avoid being burned, do not remove the radiator cap while the engine and radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is taken off too soon.

NOTICE: DO NOT USE "BOIL OUT" TANKS OR VATS. Common service methods may destroy an aluminum radiator. Do not use caustic or lye cleaning solutions for aluminum radiators. USE CLEAN WATER WHEN SERVICING ALUMINUM RADIATORS.

- Do not open the hood if you can see or hear steam or coolant escaping from the engine compartment.
- Do not remove the radiator cap if the radiator feels warm.
- Do not remove the radiator cap or coolant recovery cap if the coolant in the recovery tank looks like it is boiling.
- Wear eye protection.
- Wear gloves to protect your hands against excessive heat or the effects of chemicals on your skin.
- Prevent dirt and water from entering the transmission oil cooler.
- Do not use boil-out vats or other tanks that have been used for copper and brass radiators. The flux, acid, and caustic cleaners in these tanks will attack the aluminum and cause radiator failure. Use a separate test tank containing clean water for servicing aluminum/plastic radiators.

NOTICE: Never use shop air to pressure test radiators that is not regulated at 138 kPa (20 psi). Pressures over 138 kPa (20 psi) will damage the radiator.

SPECIAL PREPARATION

For damaged areas between the cooling fins, it may be necessary to remove some of the fins. Do not remove more fins than necessary. Usually 6 mm (1/4 inch) beyond the leak or damaged area is enough to make an effective repair (figure 14).

TUBE BLOCKING

If a tube is severely damaged, it can be blocked off (figure 15).

NOTICE: Do not block off more than two tubes in a radiator. Blocking off more than two tubes will reduce the cooling capacity of the system.

Cut the tube off 6 mm (1/4 inch) from the header and pinch shut before it is cleaned and sealed. Refer to "General Core Repair."

HEADER REPAIR

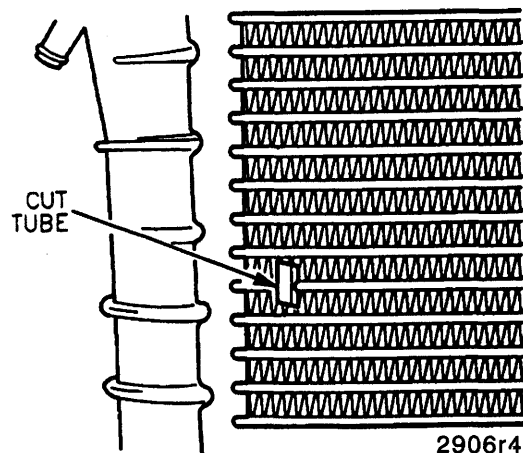
If the header or a tube near the header requires a repair, the side tank does not have to be removed. A wet cloth can be placed against the side tank where the repair has to be made (figure 16). The side tank can also be submerged in a tank of water up to the header (figure 17).

NOTICE: One of these procedures must be used when repairs are made on or near the header to prevent damage to the tank or gasket.



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Figure 14—Fins Removed from the Damaged Area



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Figure 15—Tube Blocking

GENERAL CORE REPAIR

Preparation of the repair area surface cannot be over-emphasized. If the leak area surface is not clean, the repair materials will not stick to the surface.

1. Position the core so the repair is accessible.
2. Apply a wet cloth if you are working near the plastic tanks or the joints between the core tubes and header (figure 16), or submerge the tank in water (figure 17).
3. Heat the repair area slightly with a small torch or heat gun to be sure it is dry. Do not use a blow torch.
4. Brush the area to be repaired with the small steel brush that is supplied in the kit and blow dust away from the repair area (figure 18).
5. Open the tube of primer, using the spurred cap or a pin, and apply primer to the repair area only. Use of the primer produces a stronger repair. Do not heat the primer.

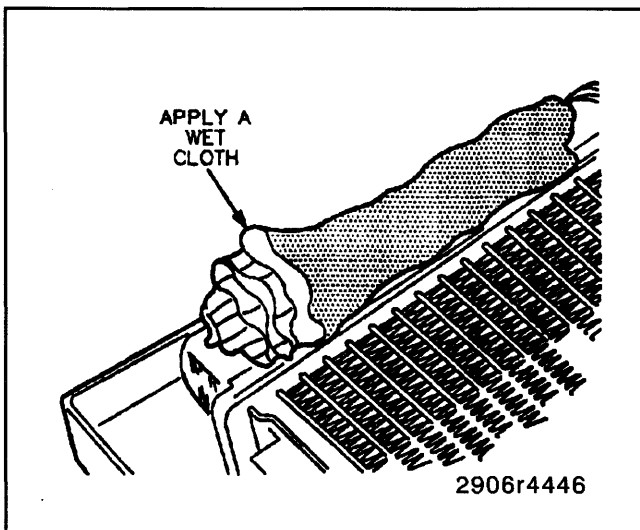


Figure 16—Using a Wet Cloth on a Side Tank

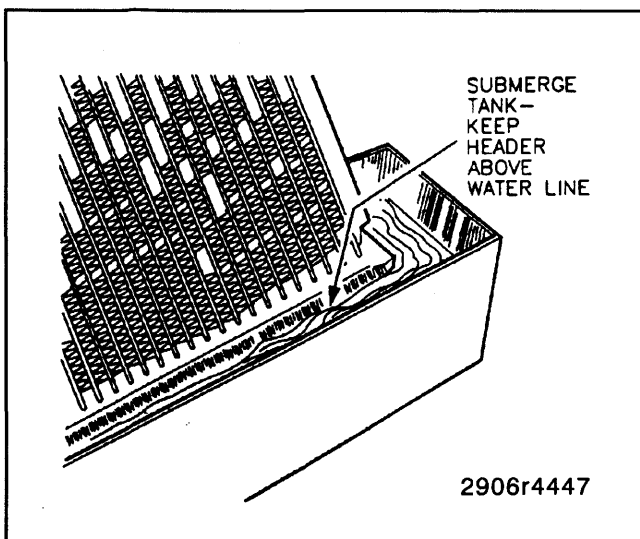


Figure 17—Submerging the Side Tank

CAUTION: The primer contains trichlorethane. It could be harmful or fatal if swallowed. If swallowed, get medical attention. Use with adequate ventilation. In case of eye contact, flush with water and get medical attention. In case of body contact, wash with soap and water. Do not mix the primer with water.

6. Scrub the repair area with a cotton swab until a fresh swab stays clean (figure 19). The clear, yellow-brown coating does not have to be removed.
7. Heat the repair area with a heat gun or by moving the torch in a circular pattern (figure 20). Use a soft, small, blue flame (like a gas stove flame).
8. Withdraw the torch and rub the adhesive stick on the repair area (figure 21). The adhesive will flow at a temperature of approximately 260°C (500°F). If the stick doesn't melt, remove it and re-apply the heat. Do not heat the stick with a flame. High heat will burn and char the adhesive.

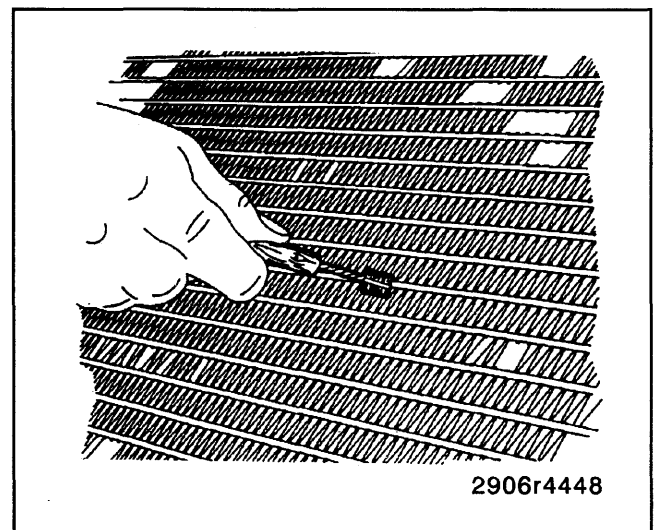


Figure 18—Cleaning the Area with a Steel Brush

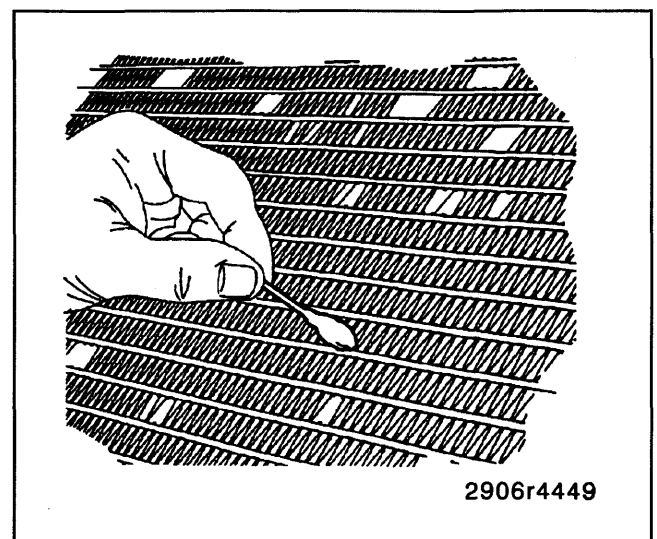


Figure 19—Scrubbing the Area with a Cotton Swab

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9. Continue heating until the adhesive flows and wets the entire repair area and fills the joint. If a hole is in the center of a tube, heat the tube and let the hot surface melt and pull in the adhesive. The force of the flame or heat gun will also tend to guide the adhesive toward the hole. For leaks between a tube and header, flow the adhesive around the tube and header joint with the tank installed.
10. Heat the repair area until the adhesive is bubble-free and smooth, with a light yellow color. Curing is not required.
11. Test the radiator for leaks when cool. If the repair area still leaks, reheat it gently to dry it. Heat and reflow the adhesive or apply more as necessary to repair the leak.

TANK GASKET LEAK REPAIR

Tank gasket leaks can be mistaken for tank or header leaks. If a plastic tank leaks from the header joint gasket, tighten the clinch tabs with locking-type pliers (figure 22) or with BT 8260 Radiator Core

Remover/Installer (figure 23). If this method doesn't seal the leak, remove the tank for further inspection.

1. Pry open the clinch tabs, except those under the inlet, outlet, and filler necks, using BT 8260 Radiator Core Remover/Installer (figure 24) or a screwdriver (figure 25). Lift the tabs only enough to allow removal.

NOTICE: Do not overbend the tabs. Overbending could result in breakage. If there are more than three tabs broken on one side of the header, or more than two adjacent tabs together, replace the core.

2. Lift the tank and slide it out from under the remaining clinched tab. You may have to tap the tank with your hand to dislodge the gasket. Lift the remaining tab(s) with pliers.
3. Remove the gasket.
4. Clean the header and gasket groove of all dirt and old rubber.
5. Clean the sealing edge of the plastic tank.
6. Examine the header gasket and surface and tank flange for evidence of leakage. Clean or repair the surface to remove dirt, burrs, and bumps.
7. Remove the oil cooler, if equipped, and install it in the new tank.

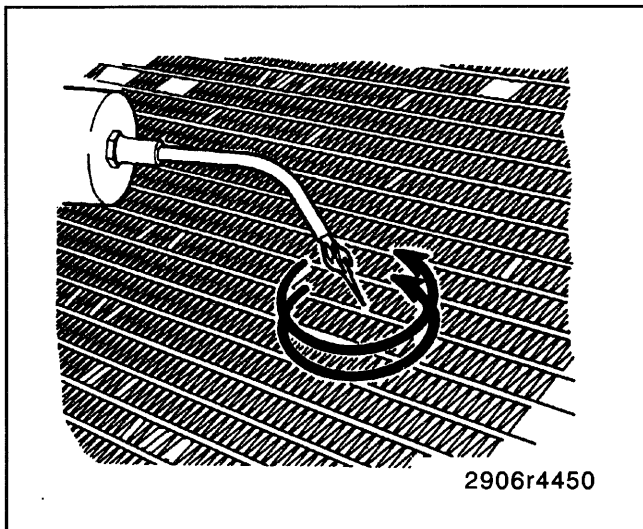


Figure 20—Heating the Repair Area

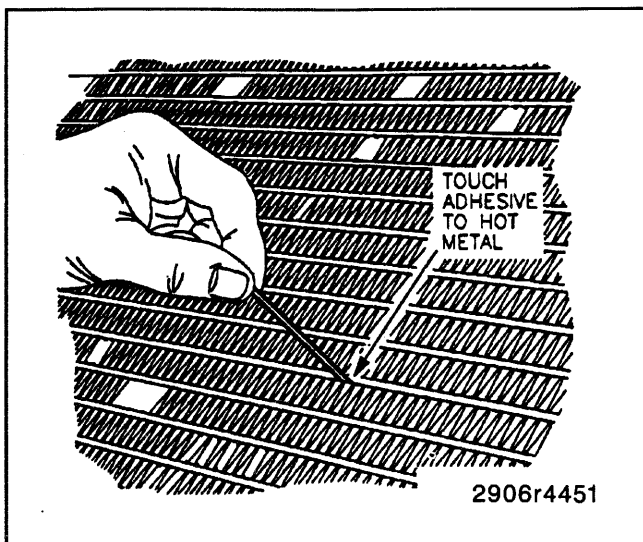


Figure 21—Applying the Hot Melt Adhesive to the Repair Area

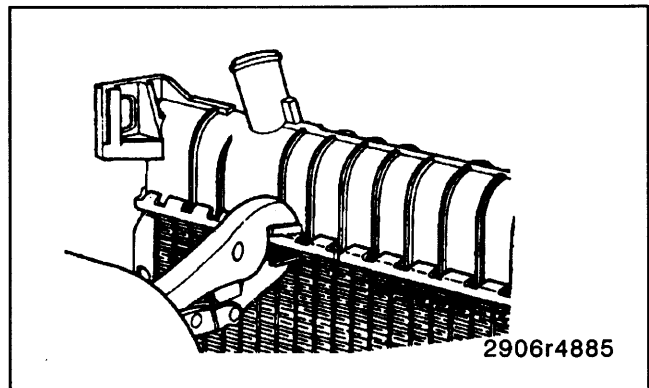


Figure 22—Tightening the Clinch Tabs

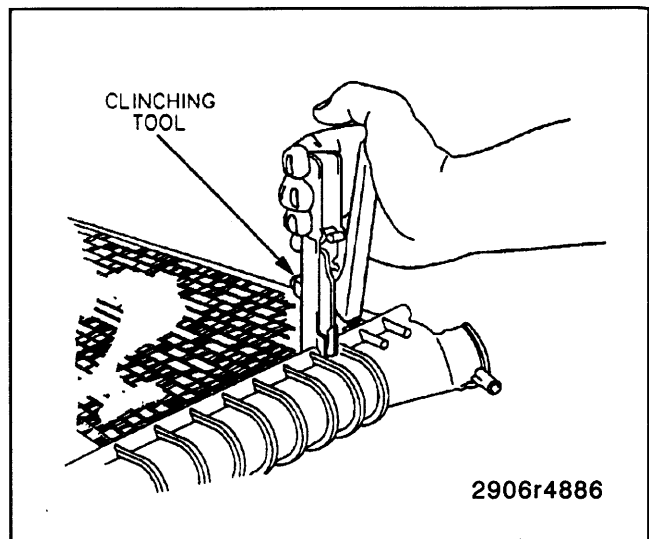


Figure 23—Tightening the Clinch Tabs

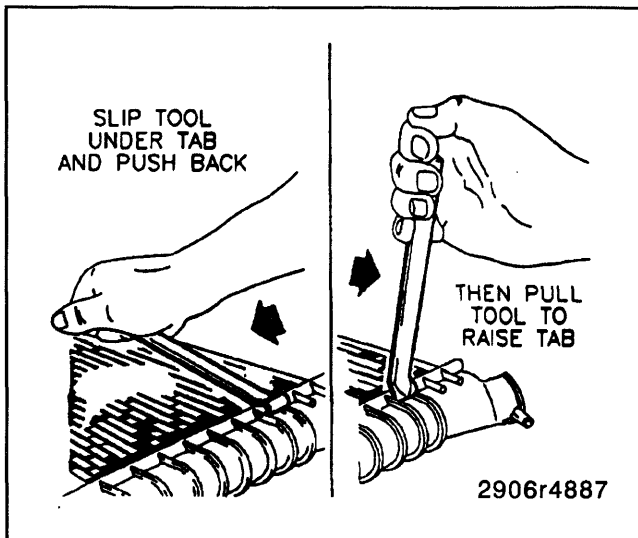


Figure 24—Opening the Clinch Tabs

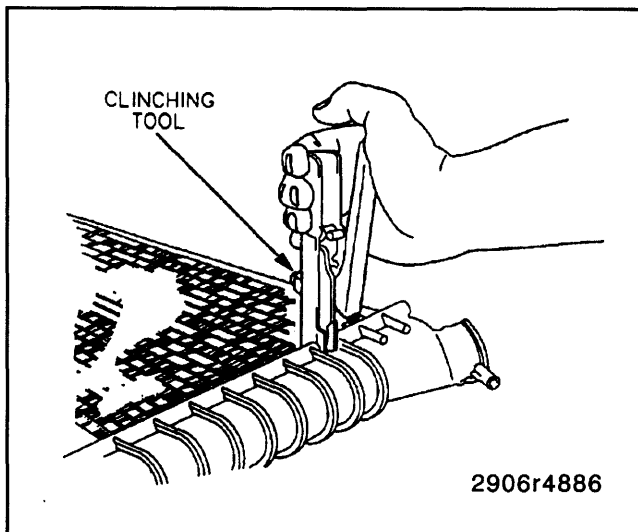


Figure 25—Opening the Clinch Tabs

8. Dip or coat the new tank gasket in engine coolant and position it on the header surface. The coolant helps hold the gasket in place.
9. Position the tank and gasket to the header. Clamp it in place and secure it by bending four clinch tabs as shown in figure 26.
10. Clamp the remaining clinch tabs around the header using the clinching tool or pliers following the clinching sequence in figure 27.

! Important

- Tighten the clinch tabs starting at the center and working out to the ends.
11. Replace the core if there are more than three tabs broken on one side or two adjacent tabs broken.
 12. Install the drain cock, if removed.
 13. Test the radiator.

OIL COOLER GASKET REPLACEMENT

Remove the outlet tank to replace the oil cooler. The oil cooler gaskets can be replaced without removing the tank.

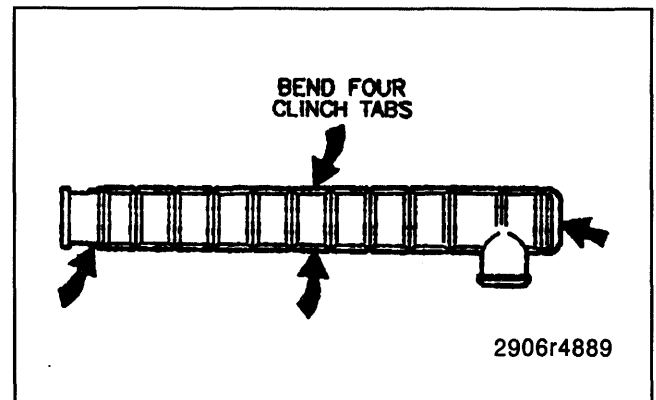


Figure 26—Seating the Tank to the Radiator Tank

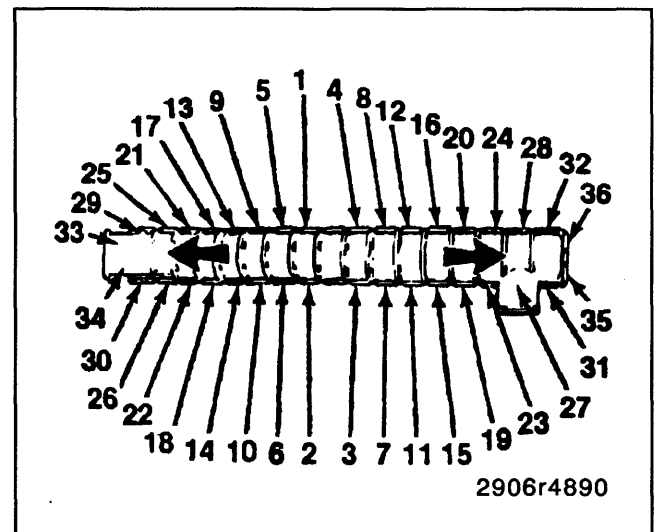


Figure 27—Clinching Sequence

↔ Remove or Disconnect (Figure 28)

1. Radiator and lay it on a flat surface.
2. Bottom oil cooler nut and loosen the top nut.
3. Press the oil cooler into the hole and remove the gasket using a small hook (figure 29).
4. Blow-dry all surfaces on the tank and oil cooler.

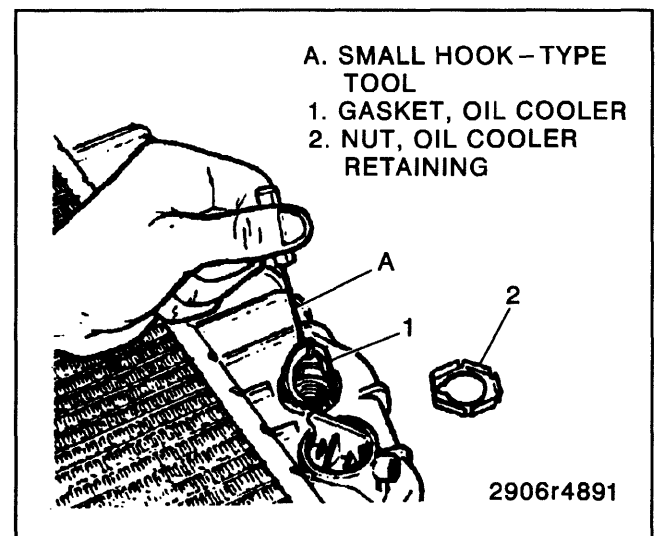


Figure 28—Removing the Oil Cooler Gasket

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 Install or Connect (Figure 28)

- 1. New gasket without lubrication.
 - Be sure it is seated properly inside the tip of the fitting.
 - Reach into the oil cooler and push it into position against the tank.
- 2. Loosely assemble the oil cooler nut.
- 3. Replace the other gasket by following the same procedure.

NOTICE: Refer to "Notice" on page 6B2-1.

- 4. Oil cooler nuts.

 Tighten

- Engine oil cooler nuts to 20 N.m (15 lbs. ft.).
 - Transmission oil cooler nuts to 27 N.m (20 lbs. ft.).
 - Do not overtighten.
- 5. Leak test.

OIL COOLER REPLACEMENT

 Remove or Disconnect (Figure 9)

- 1. Side tank or from the radiator.
- 2. Nuts from the oil cooler fitting.

- 3. Oil cooler and/or gaskets.
- 4. Rubber gaskets from the oil cooler.

 Clean

- Oil cooler gasket areas.

 Install or Connect (Figure 10)

- 1. Rubber gaskets to the oil cooler.
- 2. Oil cooler to the side tank.
 - Do not loosen or misalign the gaskets.

NOTICE: Refer to "Notice" on page 6B2-1.

- 3. Retaining nuts.

 Tighten

- Transmission oil cooler nuts to 27 N.m (20 lbs. ft.).
 - Engine oil cooler nuts (117) to 20 N.m (15 lbs. ft.).
- 4. Side tank to the radiator.
 - 5. Leak test.

RECORE

If the radiator core is damaged beyond repair and the other parts are serviceable, install the original inlet and outlet tanks, oil cooler, radiator cap, and drain valve, along with the new core and new gaskets.

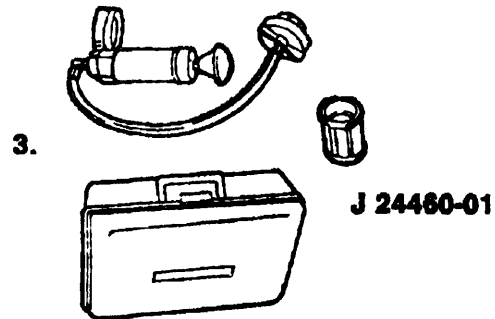
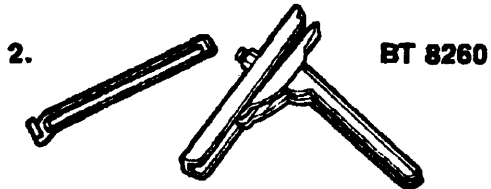
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Item	N-m	Ft. Lbs.	In. Lbs.
Engine Oil Cooler Nuts.....	20	15	—
Engine Oil Cooler Pipe Connections.....	24	18	—
Shroud and Radiator Screws.....	9	—	71
Transmission Fluid Cooler Nuts	20	15	—
Transmission Fluid Cooler Pipe Connections	26	19	—

T2130

SPECIAL TOOLS



- 1. Overflow Tube Pressure Test Adapter
- 2. Radiator Core Remover/Installer
- 3. Cooling System Tester

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NOTES

SECTION 6C

FUEL SYSTEM

(Diesel Engines Only)

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

This section covers the fuel system components for the diesel engine only.

The components of the diesel engine fuel system are the air cleaner, injection pump, injector nozzles, frame rail mounted electric fuel lift pump, engine mounted fuel manager/filter, fuel heater, water separator, fuel tank sending unit, fuel lines, fuel tank, and accelerator controls.

The air cleaner is an assembly that filters dirt and grit from the air before it reaches the engine for combustion. It also functions as a flame arrester in the case of backfire.

The fuel tank stores the fuel until it is ready to be used. A float assembly and variable resistor in the fuel sender monitors the level of fuel in the tank. The fuel lift pump draws fuel from the tank through the fuel sender. The fuel sender strains large particles from the fuel through a strainer commonly called a "sock." The fuel then passes through a fuel manager/filter that removes particles of dirt, debris, and water from the fuel before it reaches the fuel injection pump and nozzles. The fuel manager/filter also heats the fuel during cold weather operation to prevent the fuel from waxing and blocking the fuel manager/filter.

AIR CLEANER

CAUTION: The air cleaner also functions as a flame arrester in the event of engine backfire. The air cleaner should be installed at all times unless its removal is necessary for repair or maintenance. To help reduce the risk of personal injury and property damage, be sure that no one is near the engine compartment before starting the engine with the air cleaner removed. If engine backfire occurs with the air cleaner removed, there could be a burst of flame and possibly other fire in the engine compartment. On vehicles with diesel engines, do not use starting fluids—immediate engine damage can result. Also take care not to let objects fall into the engine if the air cleaner is removed. If the engine is running, suction can pull loose objects into the engine. Objects pulled or dropped into the engine can cause costly engine damage.

When replacement of the air cleaner filter is necessary, an AC® air cleaner filter or equivalent is recommended.

Refer to SECTION 0B for change intervals. Operation of the vehicle in dusty areas will necessitate more frequent replacement.

AIR CLEANER FILTER REPLACEMENT

NOTICE: Use extreme care when removing the air cleaner filter. Remove the air cleaner filter slowly to prevent dirt from falling into the engine. Failure to do so can cause engine damage.

NON-TURBOCHARGED ENGINES (L49, VIN P)

↔ Remove or Disconnect (Figures 1 and 2)

1. Wing nuts or clips.
2. Air cleaner cover from the base.
3. Air cleaner filter.
4. All accumulated dirt from the base.

🔍 Inspect

- Air cleaner filter for damage or excessive dirt accumulation. Replace if necessary.
- Seals or gaskets for damage.

↔ Install or Connect (Figures 1 and 2)

1. Air cleaner filter.

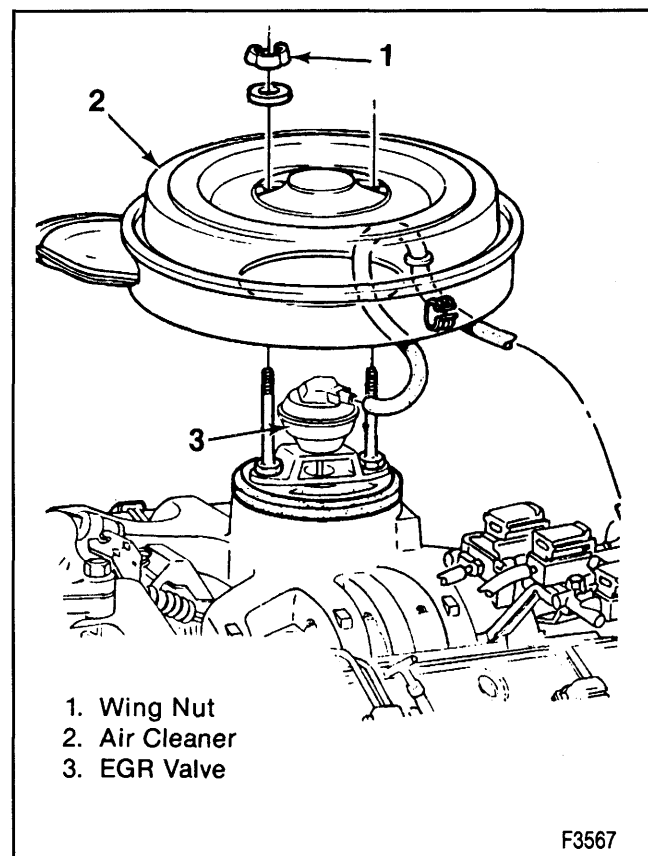


Figure 1—Air Cleaner Components (L49, VIN P)

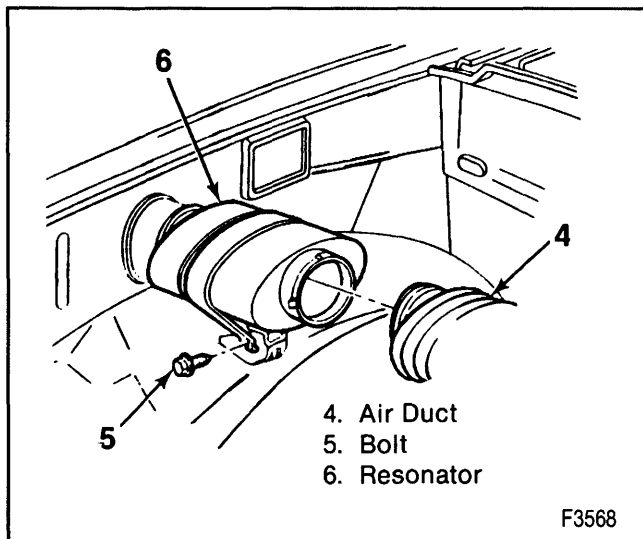


Figure 2—Air Cleaner Resonator (L49, VIN P)

2. Air cleaner cover.
3. Wing nuts or clips.

**TURBOCHARGED ENGINES
(L56, VIN S and L65, VIN F)**

Remove or Disconnect (Figures 3, 4, and 5)

1. Crankcase depression regulator (CDR) hose from air inlet intake duct.
2. Air intake duct from turbocharger and air cleaner.
3. Clips holding air cleaner cover to the housing.

4. Air cleaner filter.

Inspect

- Air cleaner filter for damage or excessive dirt accumulation. Replace if necessary.
- Air intake duct and CDR tube for damage or cracks. Replace if necessary.

Install or Connect (Figures 3, 4, and 5)

1. Air cleaner filter.
2. Air cleaner cover to housing and clip into place.

NOTICE: Refer to "Notice" on page 6C-1.

3. Air intake duct to air cleaner cover and turbocharger with clamps.

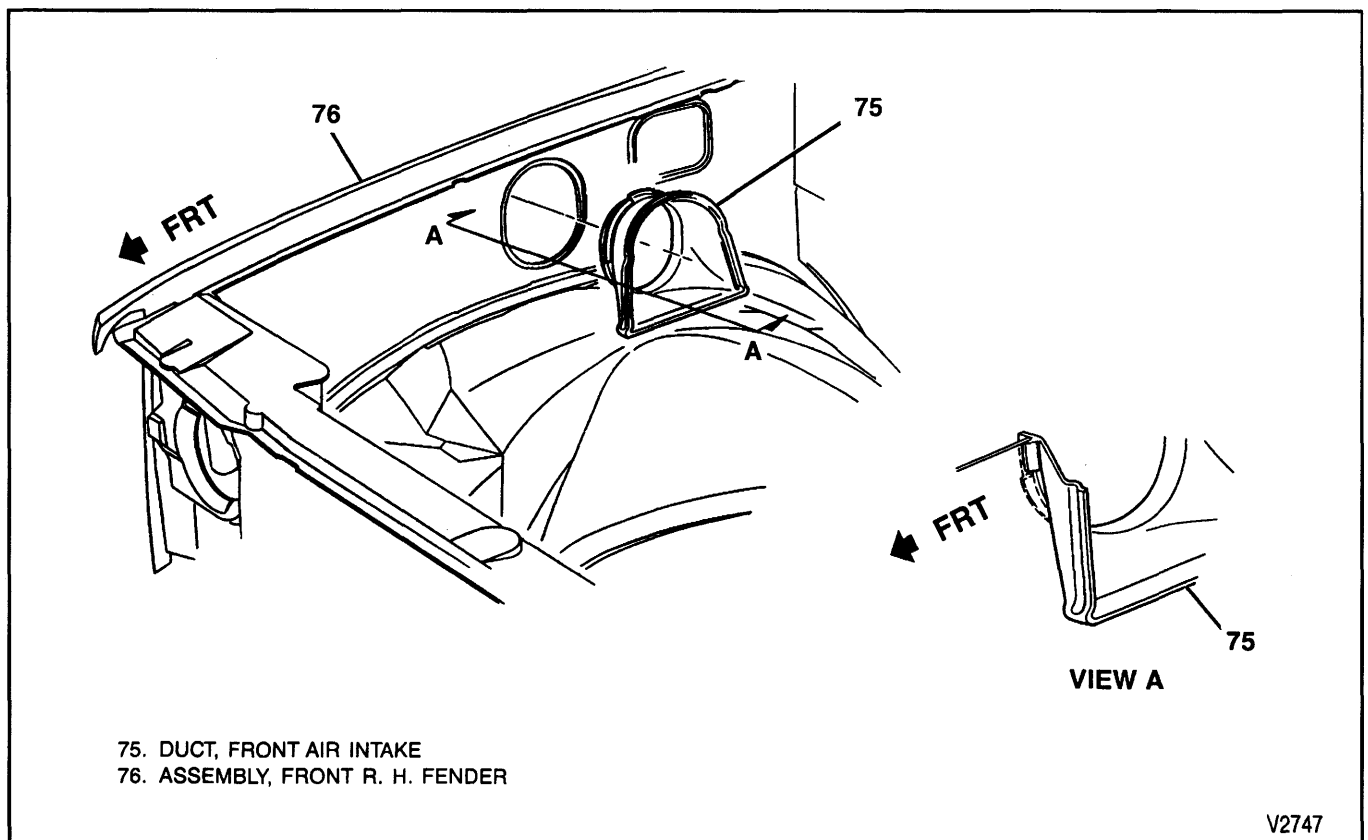
Tighten

- Clamps to to 1.7 N·m (15 lbs. in.).
4. CDR valve into air intake duct.

**RESONATOR ASSEMBLY
REPLACEMENT**

Remove or Disconnect (Figure 2)

1. Air intake duct.
2. Resonator clamp bolt.



75. DUCT, FRONT AIR INTAKE
76. ASSEMBLY, FRONT R. H. FENDER

V2747

Figure 3—Air Intake Duct Adapter (L56, VIN S and L65, VIN F)

6C-4 FUEL SYSTEM

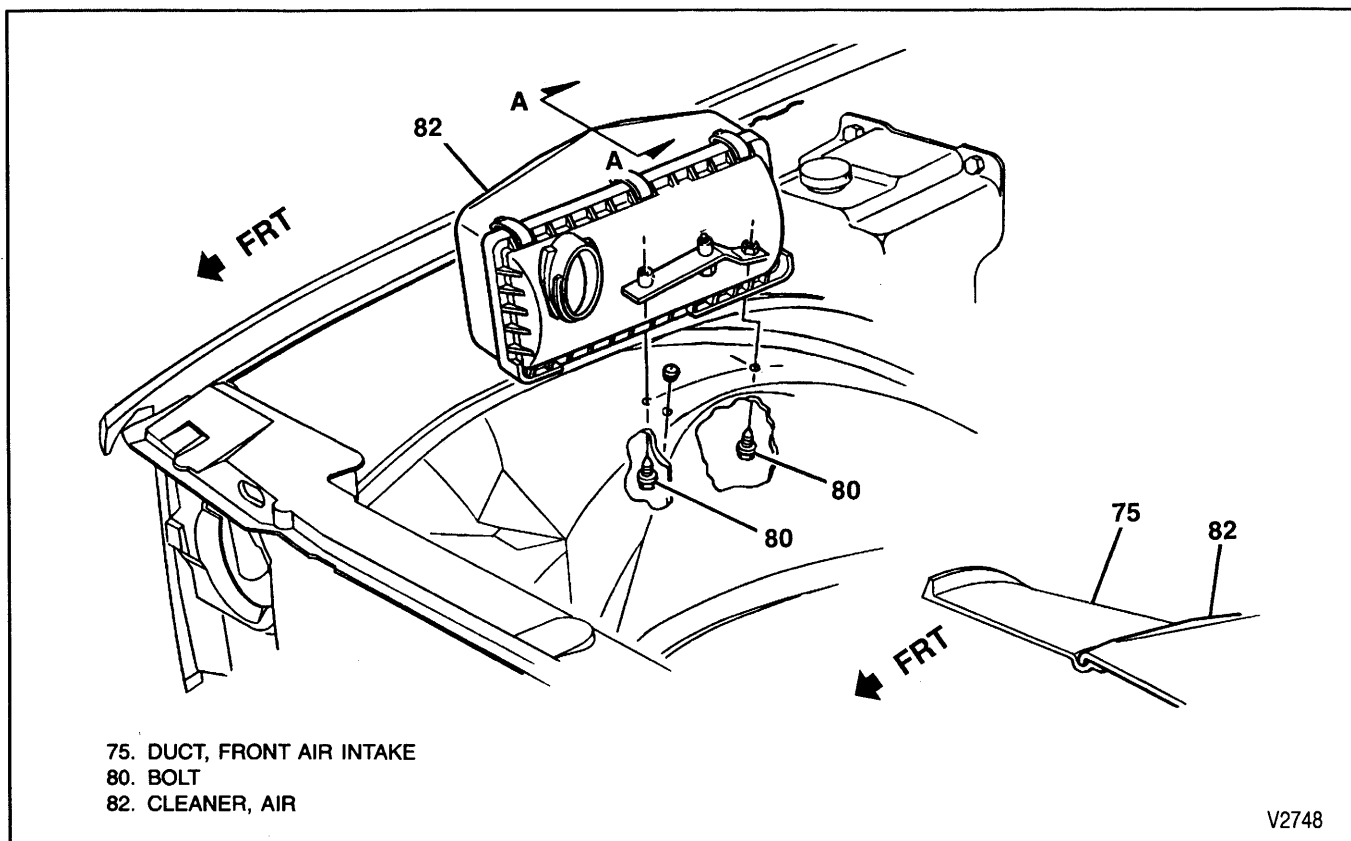


Figure 4—Air Cleaner Mounting (L56, VIN S and L65, VIN F)

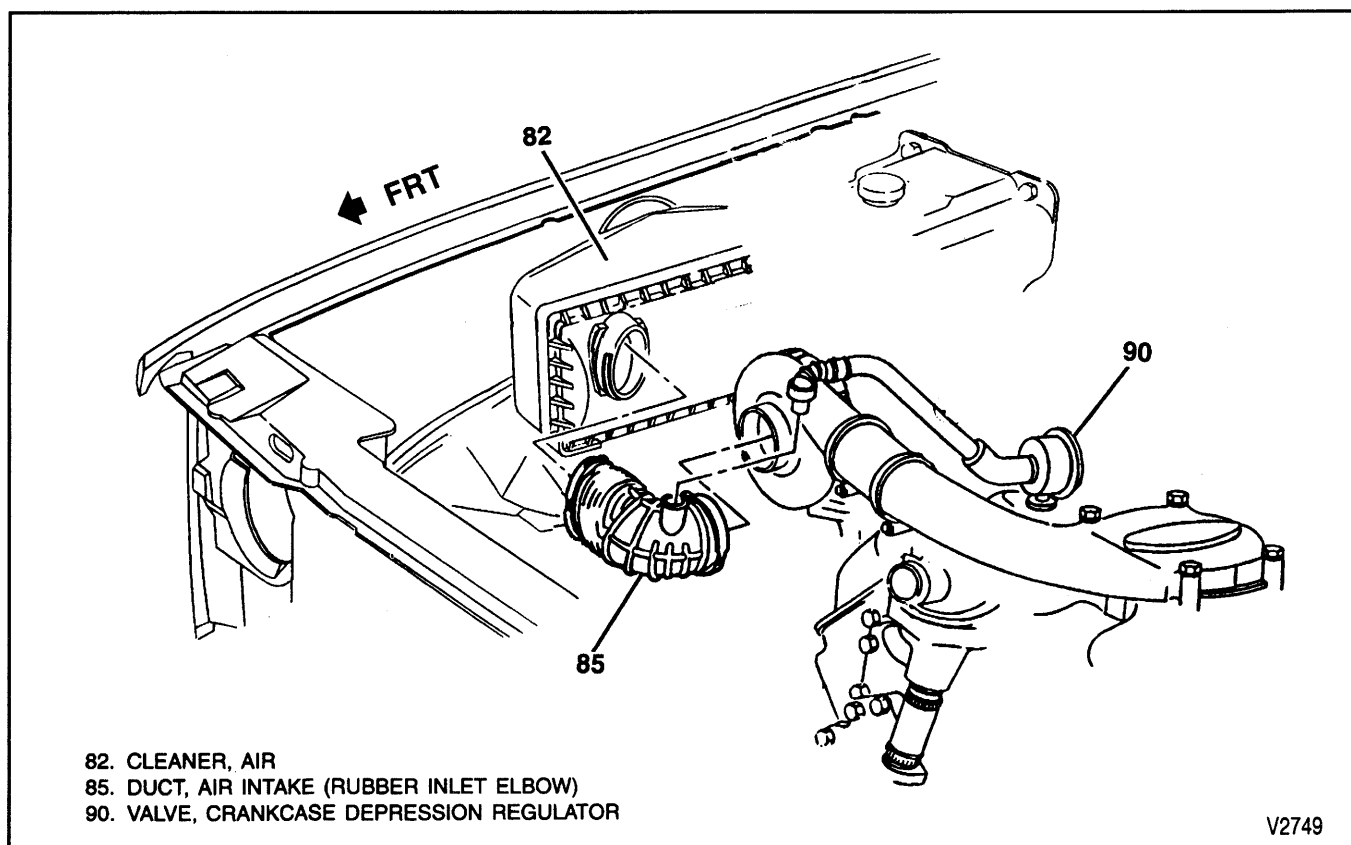


Figure 5—Air Cleaner Connections (L56, VIN S and L65, VIN F)

3. Resonator from the vehicle.

 **Install or Connect (Figure 2)**

1. Resonator to the vehicle.

NOTICE: Refer to "Notice" on page 6C-1.

2. Resonator clamp bolt.

 **Tighten**

• Bolt to 10 N.m (89 lbs. in.).

3. Air intake duct.

DIAGNOSIS OF "WATER IN FUEL" LAMP (DIESEL ENGINE ONLY)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Light Stays on or Intermittent Light	• Water in fuel filter.	• Drain water from the fuel filter.
Light Stays On With Engine Running (Temperature Below Freezing)	• Fuel filter is clogged with ice.	• Drain the fuel filter. If no water is drained, open the air bleed and check for fuel pressure. Replace the filter element if there is no pressure.
Light Stays On Continuously And Engine Stalls And Will Not Restart (After Refueling).	• Large amounts of water pumped into the tank.	• Purge the fuel tank.

D0014

DIESEL ENGINE FUEL FILTERS

The diesel engine fuel filter is an inline type filter which combines several different functions. It acts as a two-stage fuel filter, water separator, water detector, water drain, and a fuel heater (figure 7).

The first stage of the filter element is a water coalescor. The coalescor element combines small droplets of water into larger drops. The water collects in the bottom of the filter for draining. The fuel then passes through the second stage of the filter element which is a paper filter.

The filter acts as a water detector by turning on the

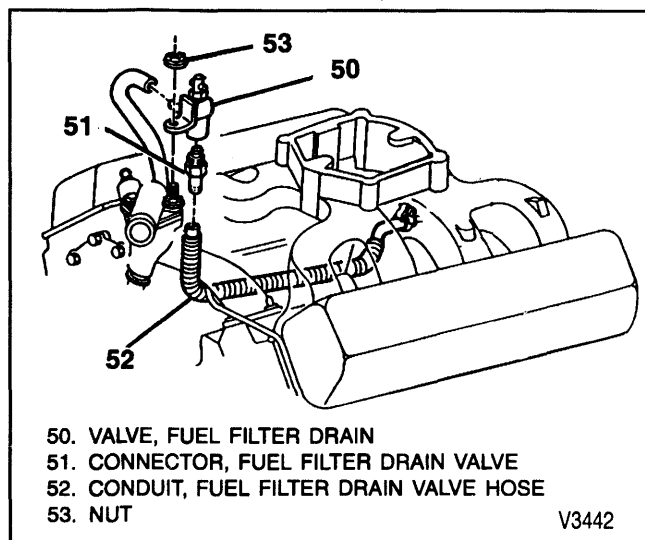
"WATER IN FUEL" lamp on the instrument panel. The probe of the water detector will touch water when water has collected to a predetermined level in the filter. This completes a circuit at the water sensor to turn on the "WATER IN FUEL" lamp.

NOTICE: If the "WATER IN FUEL" lamp comes on and the fuel system is not purged of water, fuel injection system damage may result.

When the lamp comes on, the filter should be drained as soon as practical, but within one to two hours of engine operation.

A water drain is located in the bottom of the fuel filter assembly. By opening the water drain valve, water that has collected in the bottom of the filter element can be drained (figure 6).

A fuel heater is located in the fuel filter assembly to help prevent fuel waxing. The heater thermostat turns the heater on at about 8° C (46° F) and off at about 29° C (85° F). The heater uses 7 to 13 amps depending on fuel temperature.



50. VALVE, FUEL FILTER DRAIN
51. CONNECTOR, FUEL FILTER DRAIN VALVE
52. CONDUIT, FUEL FILTER DRAIN VALVE HOSE
53. NUT

V3442

Figure 6—Fuel Filter Drain Valve

DRAINING WATER FROM THE FUEL MANAGER/FILTERS

1. Turn off the engine and block drive wheels.
2. Remove the fuel filler cap to release any pressure or vacuum in the fuel tank.

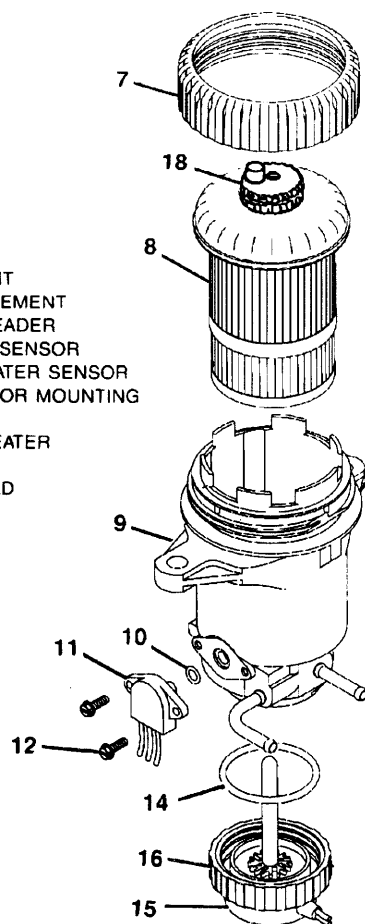
6C-6 FUEL SYSTEM

3. Place a suitable container under the filter drain hose.

CAUTION: The water/diesel fuel mixture is flammable, and could be hot. To help avoid personal injury and/or property damage, do not touch the fuel coming from the drain hose, and do not expose the fuel to open flames or sparks.

Be sure you do not overfill the container. Heat (such as from the engine) can cause the fuel to expand. If the container is too full, fuel could be forced out of the container. This could lead to a fire and the risk of personal injury and/or vehicle damage.

4. Open the drain valve.
5. Start the engine and allow it to idle for one to two minutes or until clear fuel is observed.
6. Close the drain valve and stop the engine.
7. Install the fuel filler cap.
8. Dispose of the drained mixture in a proper manner.



3106r2639

Figure 7—Diesel Fuel Manager/Filter



Important

- If the "WATER IN FUEL" indicator lamp remains lit after the fuel manager/filter is purged of water, remove the water sensor assembly refer to "Water Sensor Assembly Replacement." Wipe the tip of the water sensor clean. Reinstall the water sensor. If the "WATER IN FUEL" lamp remains lit, replace the water sensor assembly.

DRAINING FUEL FROM FILTER ELEMENT HOUSING

- Before removing the fuel filter, the filter housing should be drained. This will remove water and any other contaminants from the filter housing. The following procedure outlines how to drain fuel from the FM100 fuel filter:

- A. Turn off the engine and block the drive wheels.
- B. Remove fuel filler cap to release any pressure or vacuum in the fuel tank.
- C. Place a suitable container under the filter drain hose.
- D. Start the engine and open the filter drain valve. Once fuel begins to flow from the drain hose, open the air bleed valve on top of the fuel filter. Turn off the engine.



Important

- Opening the air bleed valve and shutting the engine off will cause the fuel in the filter housing to syphon out the drain hose.
- E. Close the drain valve and air bleed valve after all the fuel is drained from the filter housing.

DIESEL FUEL MANAGER/FILTER ELEMENT REPLACEMENT



Remove or Disconnect (Figure 7)

1. Element nut turn it by hand to the left. If unable to turn by hand, a strap wrench (oil filter type) may be used to "break loose" the element nut.
2. Element by lifting it straight up and out of the header assembly. It is not necessary to drain all the fuel from the header assembly to change the filter element since the fuel will remain in the header assembly's cavity.



Important

- Make sure the mating surface between the element assembly and the header assembly is clean before installation.



Install or Connect (Figure 7)

1. New element assembly by aligning the widest key slot located under the element assembly cap with the widest key in the header assembly.
 - Push the element in a downward direction until the mating surfaces make contact.

2. Element nut.



Tighten

- Element nut securely by hand.
- Bleed air from the fuel manager/filter as follows:
 - A. Open the air bleed valve on top of the fuel manager/filter assembly.
 - B. Connect a hose to the air bleed valve located on top of the element assembly and place the other end of the hose into a suitable container.

CAUTION: The water/diesel fuel mixture is flammable, and could be hot. To help avoid personal injury and/or property damage, do not touch the fuel coming from the drain hose, and do not expose the fuel to open flames or sparks.

Be sure you do not overfill the container. Heat (such as from the engine) can cause the fuel to expand. If the container is too full, fuel could be forced out of the container. This could lead to a fire and the risk of personal injury and/or vehicle damage.

- C. Disconnect the fuel injection pump shutdown solenoid wire.
- D. Crank the engine in 10 to 15 second intervals until clear fuel is observed at the air bleed hose (wait for one minute between cranking intervals).
- E. Close the air bleed valve.
- F. Connect the shutdown solenoid wire and reinstall fuel filler cap.
- G. Start the engine and allow to run for 5 minutes at idle.
- H. Check the fuel manager/filter for leaks.

WATER SENSOR ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 7)

1. Fuel filler cap to release vacuum in the fuel tank.
2. Mounting bolts that connect the fuel manager/filter to the intake manifold. Move the fuel manager/filter to a position that enables access to the sensor mounting screws.
3. Water sensor wiring harness.
4. Water sensor mounting screws.



Install or Connect

NOTICE: For steps 2 and 3, refer to "Notice" on page 6C-1.

1. New water sensor and a water sensor seal.
2. Water sensor mounting screws.



Tighten

- Screws to 2 N.m (13 lbs. in.).

3. Fuel manager/filter to intake manifold with mounting bolts.



Tighten

- Bolts to 25 N.m (18 lbs. ft.).

HEATER ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 7)

1. Fuel filler cap to release any vacuum in the fuel tank.
2. Mounting bolts that attach the fuel manager/filter to the intake manifold.
3. Wiring harnesses and fuel hoses.
4. Fuel manager/filter.

DIAGNOSIS OF THE HEATER ASSEMBLY

- A. Connect the heater to a variable voltage source and adjust to 12 volts D.C.
- B. Wet the heater element with diesel fuel or calibrating fluid.
- C. Cool the heater head in the area above the O-ring seal with ice, until the heater element begins to give off a vapor from the heated fuel. This will indicate that the heater switch has closed and the element is heating.

NOTICE: Do not allow the heater to remain on for longer than 30 seconds or damage to the heater element may occur.

- D. If the heater element does not heat, replace the element.



Install or Connect (Figure 7)

1. A new cap seal onto the heater assembly to header assembly sealing surface. Make sure the sealing surface is clean.
2. Heater assembly.
3. Cap nut.



Tighten

- Cap nut securely by hand.
- 4. Fuel hoses and wiring harnesses.
- Position fuel manager/filter to intake manifold.

NOTICE: Refer to "Notice" on page 6C-1.

5. Fuel manager/filter to intake manifold bolts.



Tighten

- Bolts to 25 N.m (18 lbs. ft.).
- 6. Bleed air from the filter assembly. Refer to "Diesel Fuel Filter/Manager Element Replacement."

FUEL PUMP

ELECTRIC LIFT PUMP

An electric lift pump is bracket mounted on the inside of the left framerail. The lift pump receives power from two circuits, one while the engine is cranking and the other when the engine is running.

The lift pump is designed to move fuel from the fuel tank and deliver it through the filter to the injection pump. To operate correctly, the injection pump must have fuel at the correct pressure and no air bubbles. The engine will run even though the lift pump is not operating, but the engine may experience a loss of power, stalling, and poor starting conditions.

LIFT PUMP CIRCUIT CHECK

The electrical circuits for the lift pump involve the oil pressure switch/sending unit, relay, in-line fuse, and lift pump. When the ignition switch is moved to the "CRANK" position, the lift pump circuit is completed through the relay contacts. During engine cranking, oil pressure increases to the point of closing the contacts of the oil pressure switch/sending unit. A minimum of 28 kPa (4 psi) is required to close the switch contacts.

When the engine starts and the ignition switch is returned to the "RUN" position, the oil pressure of the running engine maintains electrical power to the lift pump through the oil pressure switch/sending unit.

FUEL PUMP TESTS

If the fuel system is suspected of not delivering enough fuel, it should be inspected. Perform the "Fuel Pump Flow Test" and "Fuel Pump Pressure Test."

- Make sure there is sufficient fuel in the tank.
- Check for leaks at all fuel connections from the fuel tank to the injection pump.
- Tighten any loose connections.
- With the engine running, check all hoses and lines for flattening or kinks that would restrict the flow of fuel.
- Air leaks or restrictions on the suction side of the fuel pump will seriously affect pump output.
- With the engine running, probe terminal "G" of the DLC connector for battery voltage and monitor this during vehicle operation. Uninterrupted battery voltage indicates the circuit through the oil pressure switch to the lift pump is complete. If the system fails to pass the above test, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.

FUEL PUMP FLOW TEST

1. Remove the fuel line at the fuel filter inlet.
2. Disconnect the fuel injection pump electric shutoff solenoid wire (pink wire).
3. Place a suitable container at the end of the fuel filter inlet line.
4. Crank the engine for 15 seconds.
5. The fuel pump should supply 237 ml (1/2 pint) or more in 15 seconds.
6. Install the fuel injection pump electric shutoff solenoid wire (pink wire).

7. Install the fuel line at the fuel filter inlet.
- If the system fails to pass the above test:



Inspect

- Fuel lines between the fuel filter and tank for restrictions.
 - Fuel tank sending unit for restrictions.
- If "OK" replace the fuel pump.

FUEL PUMP PRESSURE TEST

1. Remove the fuel line at the fuel filter inlet and install a tee adapter.
 2. Install a low pressure gage to the tee adapter.
 3. Run the engine for 10 to 15 seconds.
 4. Fuel pressure should be 40 to 60 kPa (5.8 to 8.7 psi).
 5. Remove tee adapter from the fuel line and reinstall line to the filter inlet.
- If the system fails to pass the above test:



Inspect

- Fuel lines between fuel filter and tank for restrictions.
 - Fuel tank sending unit for restrictions.
- If "OK" replace the fuel pump.

FUEL PUMP REPLACEMENT



Remove or Disconnect (Figure 8)

1. Negative battery cable(s). Refer to SECTION 0A.
 2. Electrical wiring from the pump.
 3. Harness from the pump support bracket.
 4. Fuel lines from the pump.
- Use two wrenches to remove the lines.
5. Pump support bracket screws.
 6. Support bracket from the brake pipes.
 7. Pump and bracket from the frame rail.

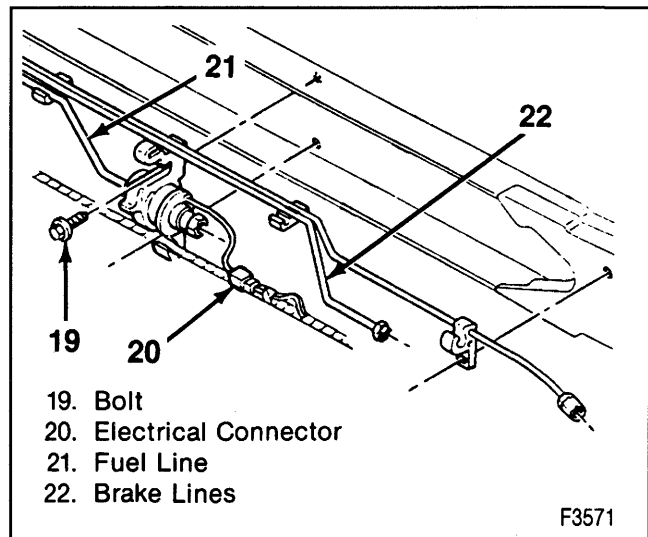


Figure 8—Fuel Pump Location

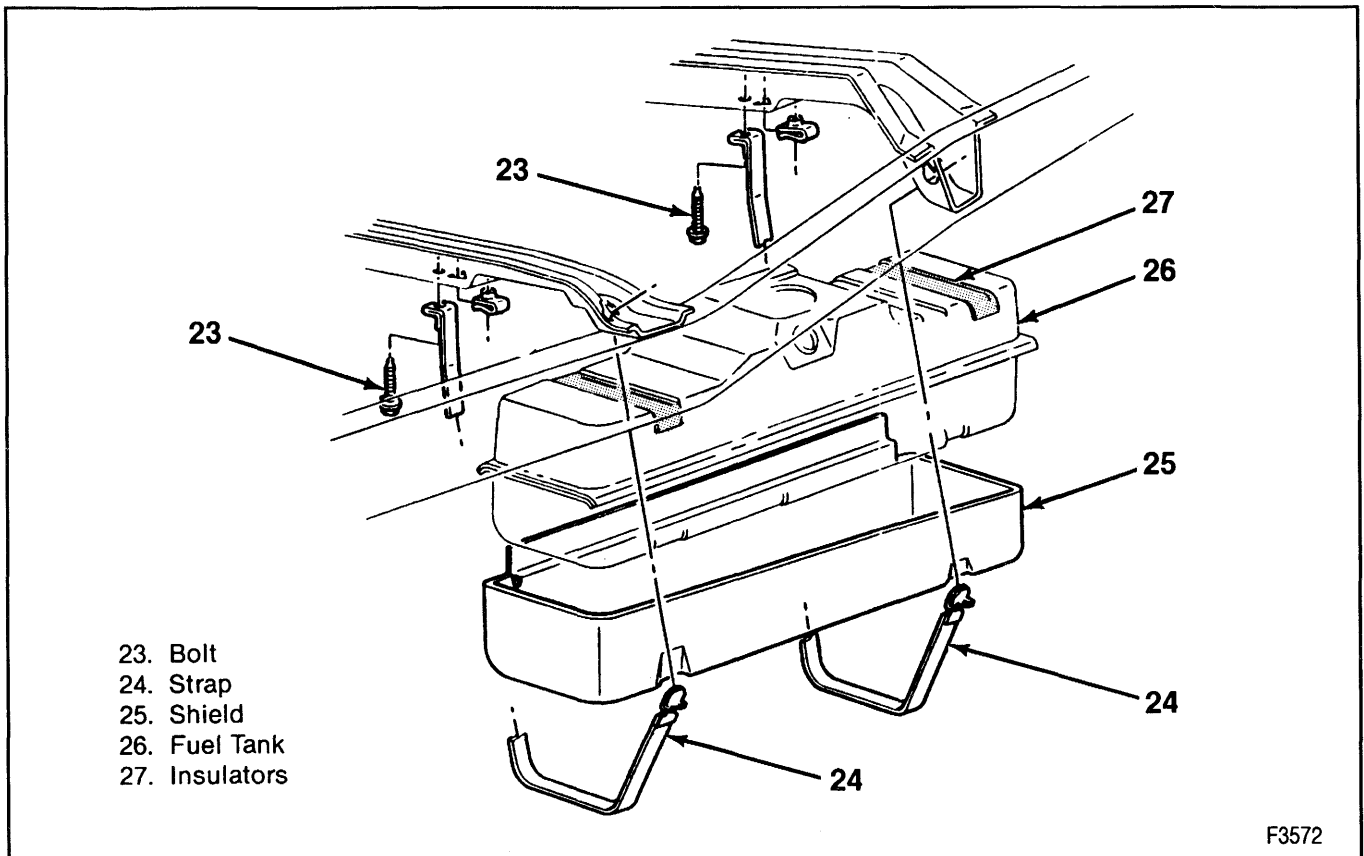


Figure 9—Fuel Tank Components (Pickup Models)



Install or Connect (Figure 9)

1. Pump and bracket to the frame rail.
2. Support bracket to the brake pipes.
3. Pump support bracket screws.

4. Fuel lines to the pump.
 - Use two wrenches to install the lines.
5. Wiring harness to the support bracket.
6. Electrical wiring to the pump.
7. Negative battery cable(s).

FUEL TANK

The fuel tank is located under the left side of the vehicle. The fuel tank is held in place by two metal straps that are attached to the underbody. Anti-squeak strips are used between the tank and the straps to reduce rattles and squeaks.

The fuel tank, filler cap, and fuel lines should be checked for damage that could cause leakage. Replace any damaged or worn parts.

Before servicing the fuel tank or lines:

- Disconnect the negative battery cable.
- Place "NO SMOKING" signs near work areas.
- Have a CO² fire extinguisher nearby.
- Wear safety glasses.
- Siphon or pump fuel into an explosion proof container.

DRAINING THE FUEL TANK



Remove or Disconnect

1. Negative battery cable(s). Refer to SECTION 0A.
 - There are two batteries in diesel engine vehicles.

- Have a dry chemical (Class B) fire extinguisher in the work area.

2. Fuel filler cap.

CAUTION: Never drain or store gasoline or diesel fuel in an open container due to the possibility of fire or explosion.

3. Fuel through the filler tube using a hand operated pump.
 - If a hand operated pump cannot be used to complete the draining, use a siphon at the main (not return) fuel pipe at the fuel pump or the fuel gage sending unit.



Install or Connect

1. Any lines or hoses.
2. Fuel filler cap.
3. Negative battery cable(s).

DIESEL FUEL SYSTEM CONTAMINATION

Fungi and other micro-organisms can survive and multiply in diesel fuel if water is present. The fungi can be present in any part of the fuel handling system. These fungi grow into long strings and will form into large globules. The growths appear slimy and are usually black, green, or brown. The fungi may grow anywhere in the fuel but are most plentiful where diesel fuel and water meet. As the fuel is agitated (when service station tanks are being filled), fungi are distributed throughout the tank and may be pumped into a vehicle.

Fungi use the fuel as their main energy supply and need only trace amounts of water and minerals. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism. The most common symptom is fuel filter plugging; however, various metal components (fuel tank, lines, and injection pump) can corrode.

CAUTION: To avoid personal injury, do not come into physical contact with biocides.

If fungi have caused fuel system problems, use a diesel fuel biocide to sterilize the fuel system. Do not exceed the dosage recommended on the label. Discontinue the use of a biocide when towing a trailer. It is permissible to have biocide in the fuel when starting to tow, but do not add any biocide while towing.

Steam cleaning may be necessary if most of the fungus growth cannot be removed with biocides.

FUEL SYSTEM CLEANING

For information about fuel system cleaning, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.

WATER IN THE FUEL SYSTEM

For information about water in the fuel system, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.

GASOLINE IN THE FUEL SYSTEM

For information about gasoline in the diesel fuel, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.

FUEL TANK PURGING

The fuel tank should be purged before being repaired.

Remove or Disconnect

1. Fuel tank from the vehicle.
2. Fuel gage sending unit.
3. All remaining fuel from the tank.

Inspect

- Fuel tank for any remaining fuel.

Install or Connect

1. Tap water into the tank until it is full.
 - A. Move the tank to the flushing area (wash rack).
 - B. Agitate the water vigorously and then drain it.

2. Gasoline emulsifying agent into the tank.
 - Use an available emulsifying agent such as Product-Sol No. 913 or equivalent.
3. Water to the fuel tank.
 - A. Refer to the emulsifying agent specifications for the mixture ratio.
 - B. Agitate the mixture for 10 minutes.
 - C. Drain the tank completely.
 - D. Fill the tank with water until it overflows.
 - E. Completely flush out any remaining mixture.
 - F. Drain the fuel tank.
 - G. Use an explosion meter (if available) to check for a negative reading.
 - H. Perform the required service work.

FUEL TANK LEAK TEST

If fuel is leaking from the tank, replace the tank. Make sure that the fuel lines are not leaking onto the tank.

1. Remove the fuel tank.
2. Drain the tank.
3. Plug all of the outlets.
4. Apply 7 to 10 kPa (1 to 1 1/2 psi) air pressure through the vent tube.
5. Test for leaks with a soap solution or by submersion.
6. Replace the tank if a leak is found.

FUEL TANK REPLACEMENT

CAUTION: To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle at the opposite end from which components are being removed. This will reduce the possibility of the vehicle falling off the hoist.

Remove or Disconnect (Figures 9, 10, and 11)

1. Fuel from the tank.
2. Fuel tank retaining straps.
 - Support the fuel tank.
3. Sending unit wire, hoses, and ground straps.
 - Lower the tank.
4. Fuel tank from the vehicle.

Install or Connect (Figures 9, 10, and 11)

1. Fuel tank into the vehicle.
 - Support the tank.
2. Sending unit wire, hoses, and ground straps.

NOTICE: Refer to "Notice" on page 6C-1.

3. Fuel tank retaining straps with the anti-squeak pieces.
 - Cement the anti-squeak material securely to the tank with 25 mm (1 inch) wide coverage for 10 cm (4 inches) on each end.

Tighten

- Retaining strap bolts or nuts to 13 N.m (115 lbs. in.).

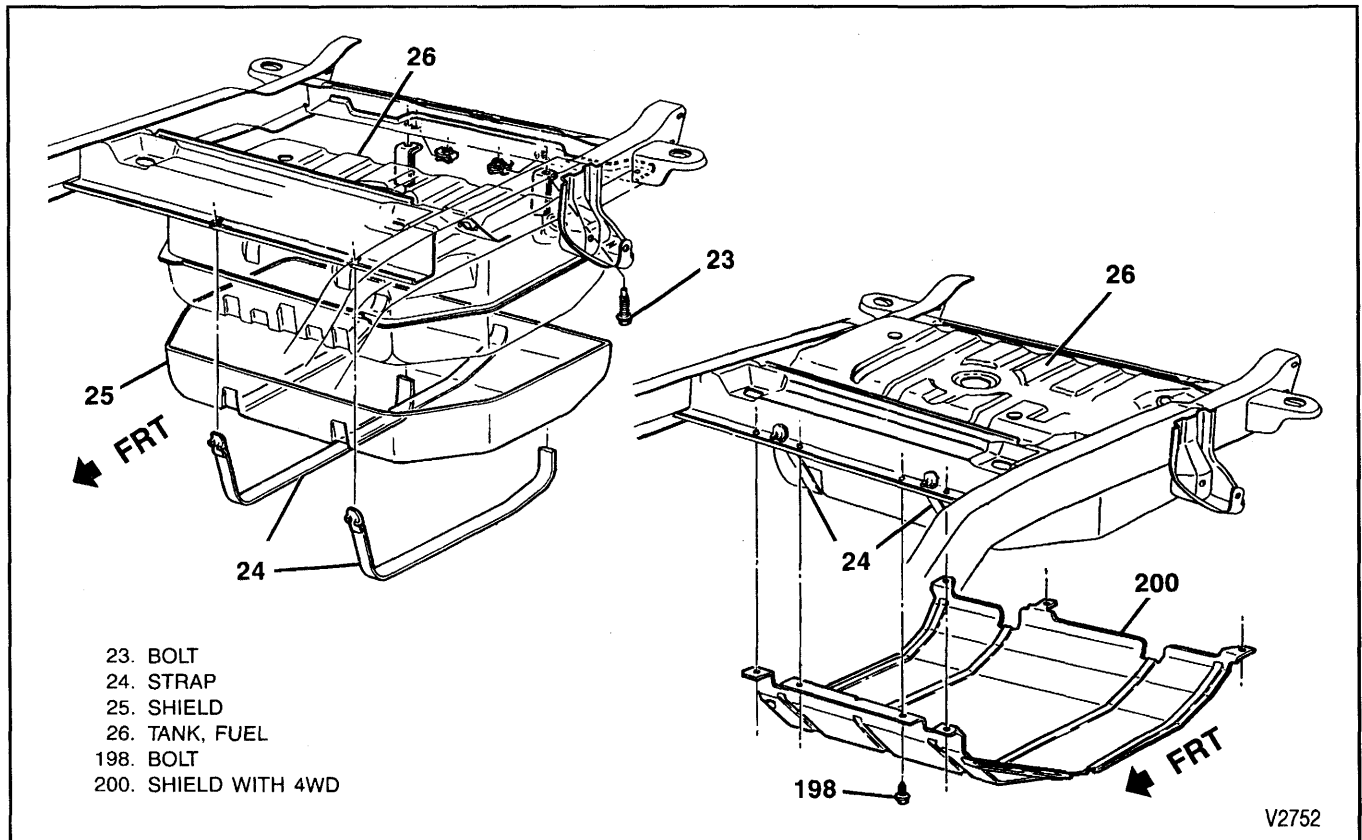


Figure 10—Fuel Tank Components (Suburban Models)

FUEL TANK FILLER NECK

The fuel tank filler neck has a vent pipe that allows air to escape from the tank while filling the tank. The fuel filler neck is shown in figures 12 and 13.

FUEL FILLER CAP

The fuel tank filler neck is equipped with a screw type cap. The cap requires several turns to the left to remove. The long threaded area allows fuel tank pressure to escape while the cap is being removed. A torque limiting device prevents overtightening. To install, turn the cap to the right until a clicking noise is heard.

NOTICE: If a fuel filler cap requires replacement, use only a cap with the same features. Failure to use the correct cap can result in a serious malfunction of the system.

FUEL LINES

NOTICE: Fuel and vapor hoses and pipes are specially manufactured. It is important to use replacement hose or pipe meeting GM Specifications. Hoses and pipes not meeting GM Specification could cause early failure or failure to meet emission standards.

When replacing fuel feed and return pipes, always use welded steel tubing meeting GM Specification 124 M or its equivalent. The replacement pipe must have the same type fittings as the original pipes to ensure the integrity of the connection.

- Never replace fuel pipe with copper or aluminum tubing.
- Check and replace any damaged O-rings or washers.
- Fuel pipes should be inspected occasionally for leaks, dents, or kinks.
- Follow the same routing as the original pipe.
- Pipes must be properly secured to the frame to prevent chafing. A minimum clearance of 6 mm (1/4 inch) must be maintained to prevent contact and chafing.

FUEL AND FUEL VAPOR HOSES

NOTICE: Fuel and vapor hoses are specially manufactured. It is important to use replacement hoses that meet GM Specification 6163-M. These hoses are identified by the word "Fluoroelastomer" marked on them. Hoses not so marked could cause early failure or failure to meet emission standards.

Do not use rubber hose within 10 cm (4 inches) of any part of the exhaust system or within 25 cm (10 inches) of the catalytic converter.

The fuel gage sending unit is mounted in the top of the fuel tank. It is held in place by a cam lock ring. A gasket is used between the tank and the sending unit.

Figure 14 shows three tubes that connect to the vehicle's fuel lines. The vapor vent hose slips over the large tube and is held in place with a clamp. Fuel feed and fuel return lines attach to the smaller tubes with O-ring type connectors.

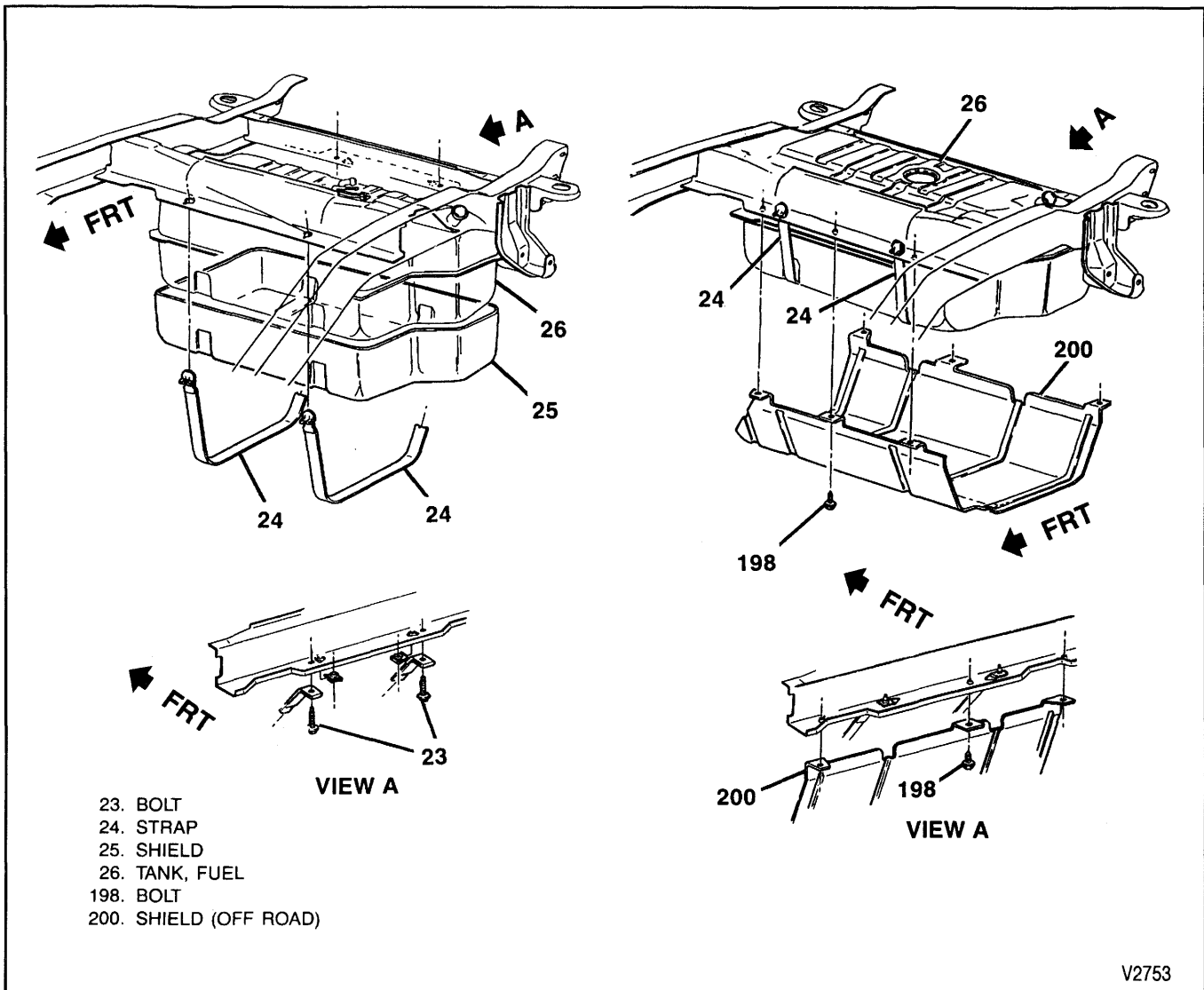


Figure 11—Fuel Tank Components (Utility Models)

IN-TANK FUEL FILTER

A woven plastic filter is located on the lower end of the fuel pickup tube in the fuel tank. This filter prevents dirt and water from entering into the fuel line unless it becomes completely submerged in water. The filter is self cleaning and normally requires no maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or water and should be thoroughly cleaned.

Diesel engine vehicles have a check valve that will permit fuel to pass if the tank filter becomes plugged with paraffin during cold weather operation.

When this plugging occurs, the last four gallons of fuel will not be used due to the location of the check valve. Therefore, it is important to keep the fuel tank above the 1/4 mark at temperatures below -6° C (-20° F) when using number two diesel fuel.

FUEL GAGE SENDING UNIT REPLACEMENT

Remove or Disconnect (Figure 14)

Tool Required:

J 36608 Fuel Gage Sending Unit Tool

1. Fuel from the tank.
2. Fuel tank from the vehicle. Refer to "Fuel Tank Replacement" in this section.
3. Locking cam using J 36608.
4. Fuel gage sending unit.
5. Gasket.

Install or Connect (Figure 14)

Tool Required:

J 36608 Fuel Gage Sending Unit Tool

1. New gasket.
2. Fuel gage sending unit.

• Take care not to fold or twist the strainer or fuel flow will be restricted.

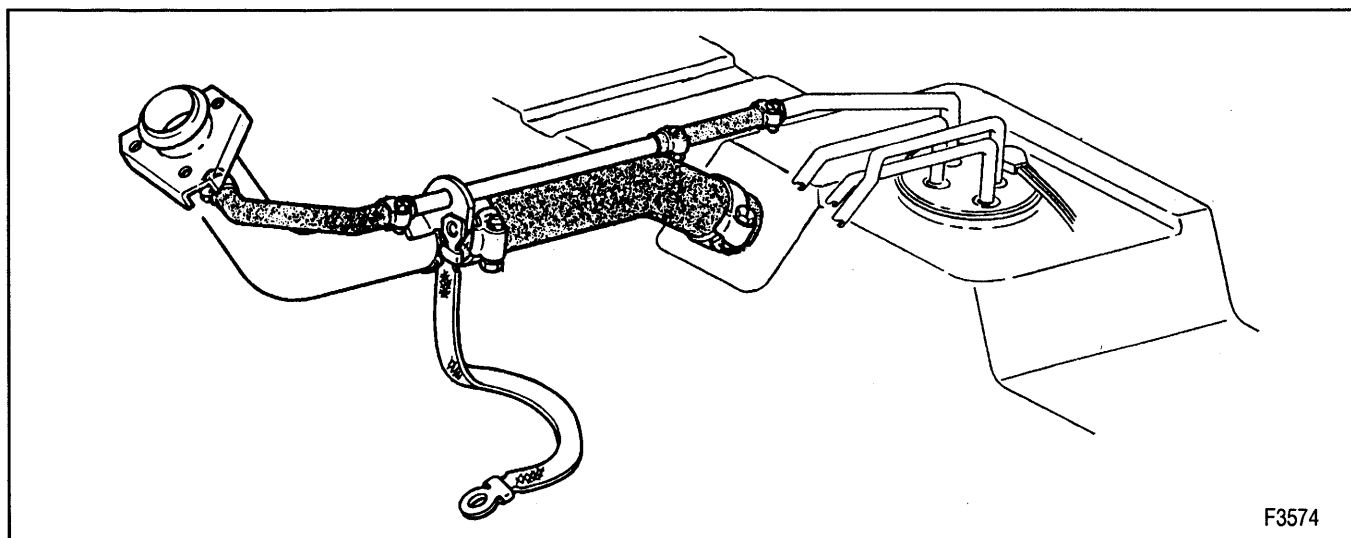


Figure 12—Fuel Filler Neck

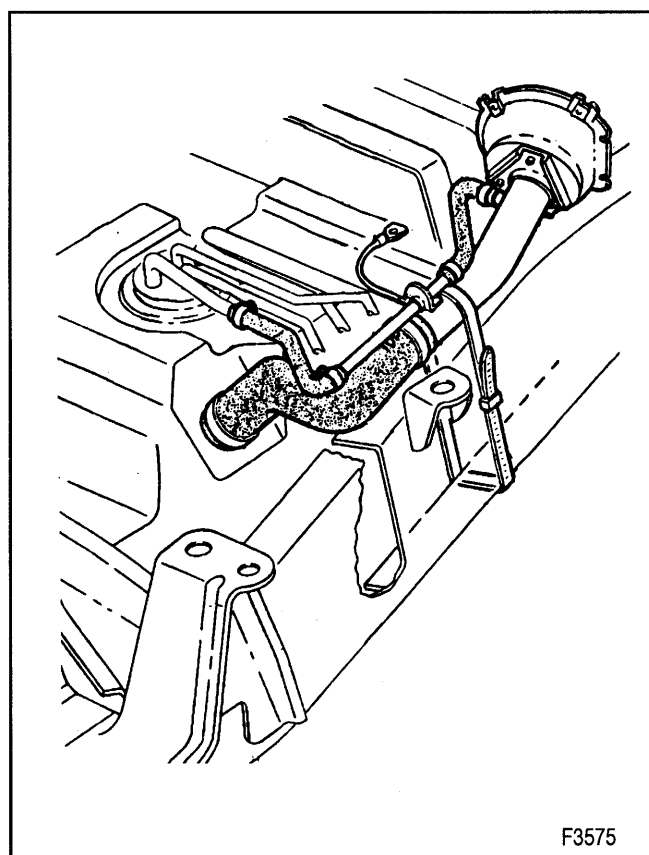


Figure 13—Fuel Filler Neck

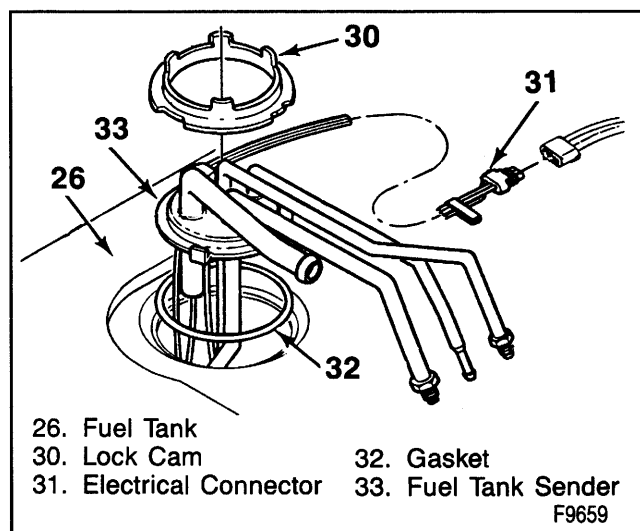


Figure 14—Fuel Tank Sender

3. Locking cam using J 36608.
4. Fuel tank into the vehicle. Refer to "Fuel Tank Replacement" in this section.

ELECTRONIC ACCELERATOR

All C/K models are equipped with an electronic accelerator. The accelerator is mounted to the dash panel (figure 15). For more information about this system, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.

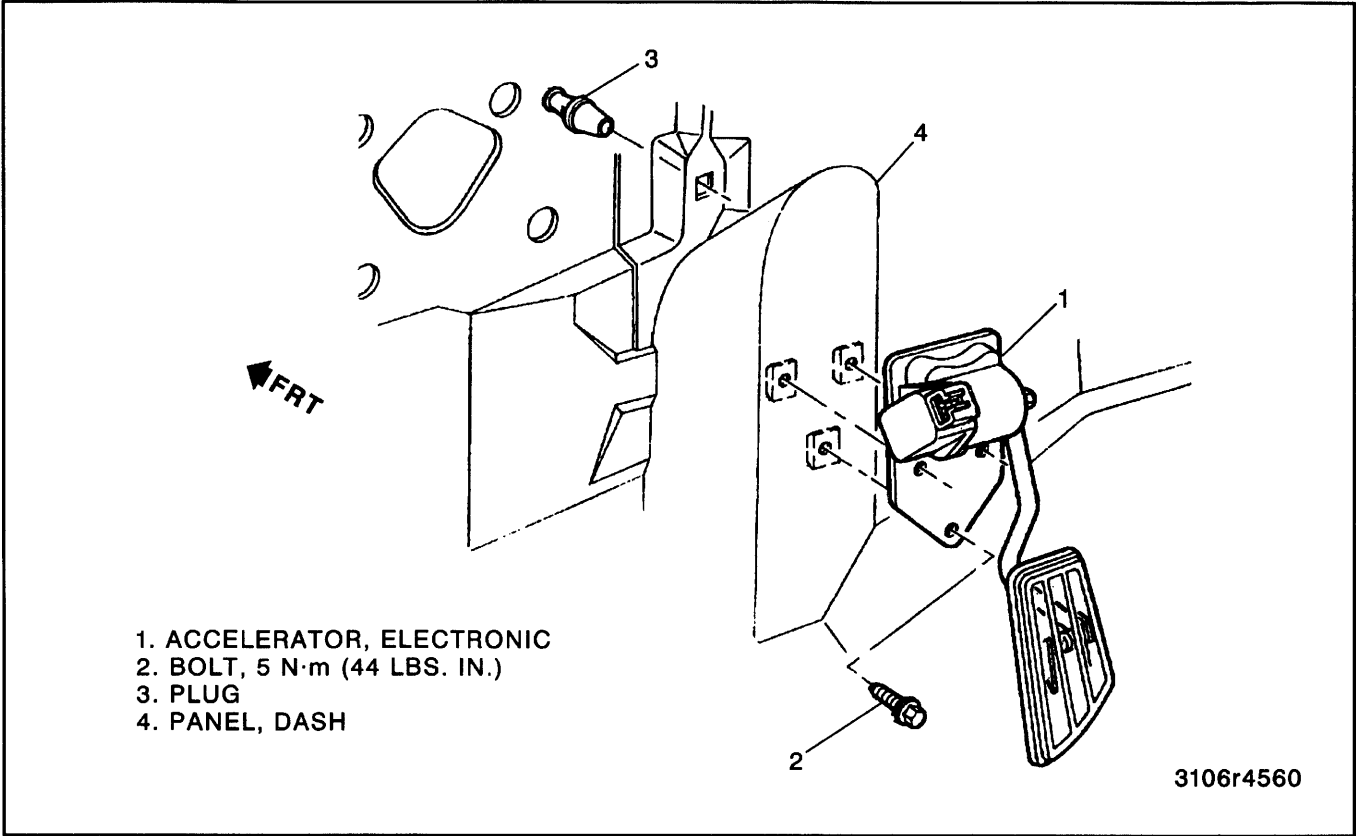


Figure 15—Electronic Accelerator

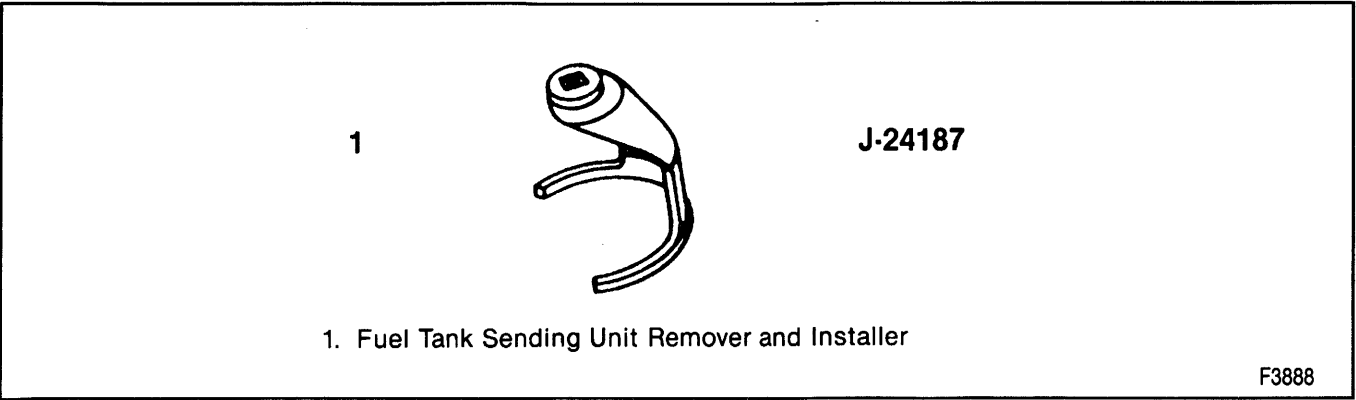
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Ft. Lbs.	In. Lbs.
Strap to Crossmember Bolts	13	—	115
Strap to Nut Bracket	13	—	115
Resonator Clamp Bolt.....	10	—	89
Water Sensor Screws	2	—	13
Fuel Filter/Manager to Intake Bolts	25	18	—
Injection Line To Nozzle Fitting	25	18	—

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SPECIAL TOOLS



SECTION 6C2

DIESEL FUEL INJECTION

The diesel engines used in C/K vehicles use an electronic fuel injection pump. For information about the electronic fuel injection pump, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.

6C2-2 DIESEL FUEL INJECTION

SECTION 6D

ENGINE ELECTRICAL

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Engine Wiring	6D5-1
Diesel Glow Plug Electrical System	6D6-1

GENERAL DESCRIPTION

6D1 - BATTERY

This section contains information on the maintenance, diagnosis, storage, charging, and jump starting of batteries. Battery cable and ground strap routing also appear in this section.

6D2 - CRANKING SYSTEM

This section covers the diagnosis, on-vehicle servicing, and specifications of the cranking circuit and starter. Disassembly and repair procedures are covered in the Light Duty Truck Unit Repair Manual.

6D3 - CHARGING SYSTEM

Generator diagnosis, on-vehicle servicing, and specifications are covered in this section. Disassembly and repair procedures are covered in the Light Duty Truck Unit Repair Manual.

6D4 - IGNITION SYSTEM

This section contains information on spark plugs and primary and secondary wiring. On-vehicle service is limited to distributor, pickup coil, and ignition coil testing. Procedures to replace the spark plugs, ignition coil, and distributor are located here. Refer to the fuel and emis-

sions section of NATP-9442 for ignition timing instructions and diagnosis. Servicing of distributor assemblies and electronic ignition systems can be found in the Light Duty Truck Unit Repair Manual.

6D5 - ENGINE WIRING

Engine wiring views are shown in section 6D5. Refer to the electrical diagrams and diagnosis section of NATP-9442 for engine wiring schematics and diagnosis. Forward lamp harness views are found in SECTION 8B.



Important

Where a driveability complaint exists, or a Diagnostic Trouble Code is set, refer to the fuel and emissions section of NATP-9442. Wiring diagrams, component locations, and system checks are located in the electrical diagrams and diagnosis section of NATP-9442.

6D6 - DIESEL GLOW PLUG ELECTRICAL SYSTEM

Diesel engines with electronic throttle controls have a glow plug electrical system that is controlled by the Powertrain Control Module (PCM). Information, including diagnosis on the PCM controlled system is presented in the fuel and emissions section of NATP-9442.

NOTES

SECTION 6D1**BATTERY**

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

BATTERY

The maintenance-free battery is standard in all vehicles (figure 1). Refer to "Specifications" for specific applications. These vehicles may be equipped with one or more batteries, depending on the powertrain used and optional equipment. The battery is completely sealed except for two small vent holes in the sides. These vent holes allow the small amount of gas produced in the battery to escape.

The battery has three functions in the electrical system: first, it provides a source of energy for cranking the engine; second, it acts as a voltage stabilizer for the electrical system; and third, it can, for a limited time, provide energy when the electrical load used exceeds the output of the generator.

The battery specification label, as shown in figure 2, contains information pertinent to the servicing of the battery. This information includes test ratings and both original equipment and recommended replacement part numbers. This information is also included in the specifications at the end of this section.

BATTERY RATINGS

A battery has two ratings: reserve capacity and cold cranking amperage.

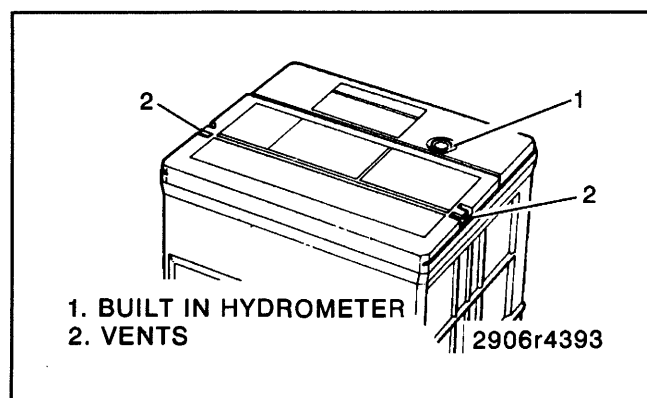


Figure 1—Maintenance-Free Battery (Side Terminals)

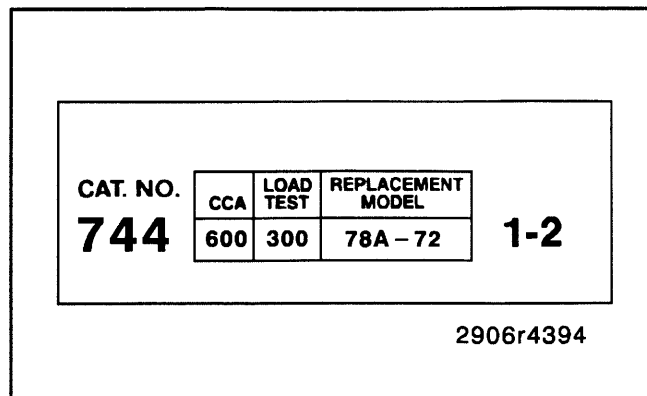


Figure 2—Battery Label (Typical)

RESERVE CAPACITY

Reserve capacity is an estimate of how long the vehicle can be driven with no generator output, the headlamps turned on, and minimum electrical load (most accessories turned off). It is the maximum amount of time (in minutes) it will take for a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27° C (80° F), to reach a terminal voltage of 10.5 volts. Other temperatures or current draws, the state of charge, the condition of the battery, etc., will affect how long the battery will actually last when the vehicle is being driven and there is no generator output.

COLD CRANKING AMPERAGE

Cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. This rating is the minimum amperage the battery must maintain for 30 seconds at -18° C (0° F), while maintaining at least 7.2 volts. The actual performance of a battery will vary with actual temperature, etc.

COMMON CAUSES OF FAILURE

The battery is not designed to last indefinitely; however, with proper care, it will provide many years of service.

If the battery tests good, but fails to perform satisfactorily in service for no apparent reason, the following are some important factors that may point to the cause of trouble:

1. Vehicle accessories left on overnight.
2. Slow average driving speeds for long periods, or short trips, as the battery may not have sufficient time to recharge.
3. The vehicle's electrical load is more than generator output, particularly with the addition of aftermarket equipment.
4. Conditions in the charging system such as poor ground circuits, electrical shorts, slipping drive belt, or a faulty generator.
5. Battery abuse, including failure to keep battery cable terminals clean and tight or operating with a loose battery hold-down.
6. Mechanical conditions in the electrical system, such as shorted or pinched wires or a cracked battery case resulting from a collision.

The outside of the battery should be checked periodically for damage, such as a cracked cover or case.

ELECTROLYTE FREEZING

The freezing point of electrolyte depends on its specific gravity. Since freezing may ruin a battery, protect it against freezing by keeping it in a charged condition. As long as the green dot shows in the built-in hydrometer, the battery will not freeze unless the temperature drops below -32° C (-25° F). A fully charged battery will not freeze unless the temperature drops below -54° C (-65° F).

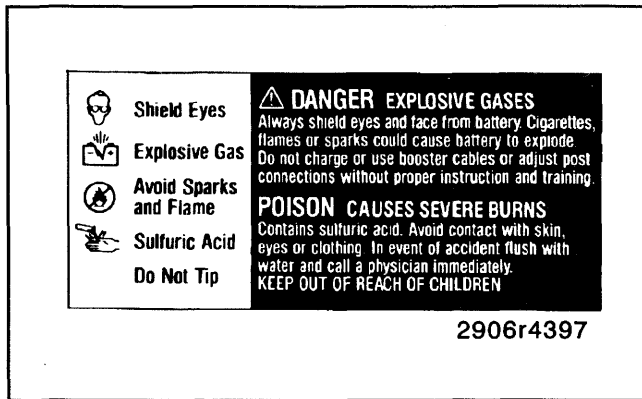


Figure 3—Safety Precautions

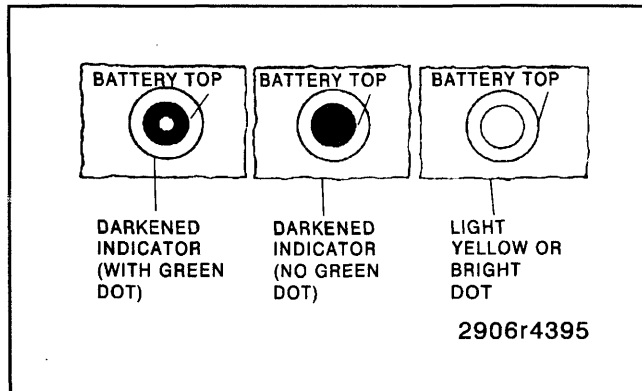


Figure 4—Built-In Hydrometer

CARRIER AND HOLD-DOWN

The battery carrier and hold-down clamp should be clean and free from corrosion before installing the battery.

The carrier should be in sound condition so that it will hold the battery securely and keep it level. Make sure there are no parts in the carrier before installing the battery.

To prevent the battery from shaking in its carrier, the hold-down bolts should be tightened to the specifications given at the end of this section.

BATTERY PROTECTION DURING VEHICLE STORAGE

CAUTION: Follow all safety precautions. Refer to figure 3.

Some electronic devices on the vehicle impose small continuous current drains on the battery; this is commonly called "parasitic load." If the vehicle is not used for an extended time, these parasitic loads can discharge and eventually cause permanent damage to the battery. Discharged batteries can also freeze in cold weather. Refer to "Electrolyte Freezing."

NOTICE: Always turn off the ignition switch when connecting or disconnecting battery cables, battery chargers, or jumper cables. Failing to do so may damage the powertrain control module (PCM) or other electronic components.

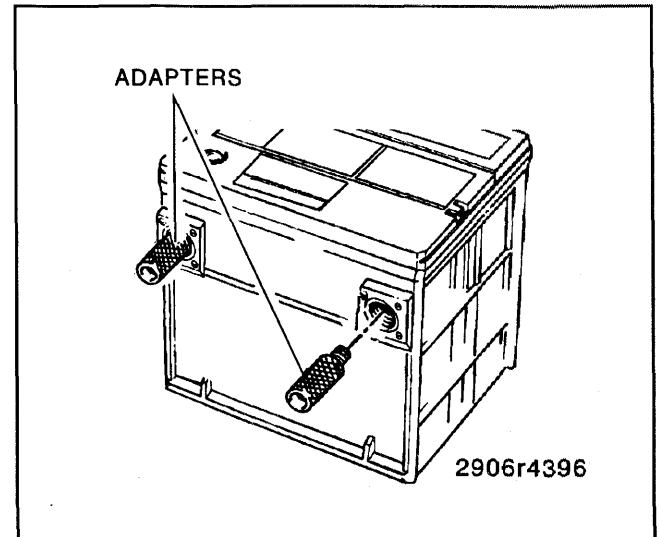


Figure 5—Battery Terminal Adapters

To help keep the battery in a charged state while storing the vehicle:

- If the vehicle is likely to be stored for over 30 days, make sure the green dot is visible, then disconnect the negative battery cable at the battery. This will protect the battery from being discharged by parasitic current drains from the vehicle's electrical system. When it is time to reconnect the battery:
 - A. Use a wire brush to lightly clean any oxidation from the contact face of the battery terminal before reattaching the cable.
 - B. Tighten the cable bolt to 15 N·m (11 lbs. ft.).
 - C. Reset the clock, pushbutton radio tuning, etc., before the vehicle is put back in service.
- If the battery cannot be disconnected, establish a regular schedule of recharging the battery every 20-45 days to maintain a high state of charge. Any time a battery is found with the green dot not visible in the hydrometer, promptly recharge the battery.
- To keep charge time low, use a battery charger that is capable of providing a charging voltage of at least 16 volts. Original equipment maintenance free batteries will not be damaged by charge rates of 50 amps or more, as long as the battery does not spew electrolyte from the vents, or get too hot - over 52° C (125° F). Every 45-60 minutes, inspect the battery being charged and stop or reduce the charge if necessary. To avoid overcharging, be sure to stop charging within one hour after the green dot appears in the hydrometer.
- Allow ample charging time. Refer to "Battery Charging."
- A battery that is allowed to remain in a discharged state for a long period of time will be difficult to recharge, and may even permanently damage the battery if it is allowed to stay discharged.

BUILT-IN HYDROMETER

Molded into the top of the maintenance-free battery is a built-in temperature compensated hydrometer (figure 4). Use this hydrometer with the following diagnostic procedure.

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When observing the hydrometer, make sure the battery has a clean top. A light may be required in some poorly-lit areas.

Under normal operation, one of three indications can be observed:

1. GREEN DOT VISIBLE

- Any green appearance in the hydrometer is interpreted as a "green dot." This means the battery is ready for testing.

2. DARK DOT, GREEN DOT NOT VISIBLE

- If the green dot cannot be seen and there is a cranking complaint, proceed to "Diagnosis of the Battery" for further testing. The charging system should be checked for output and the electrical system should be checked for excessive draws.

3. CLEAR OR LIGHT YELLOW DOT

- This means the electrolyte level is below the bottom of the hydrometer and is too low for diagnosis. This may have been caused by excessive or prolonged charging, a broken case, or excessive tipping. When finding a battery in this condition it may indicate high charg-

ing voltages caused by a faulty charging system. Therefore, the charging and electrical systems must be checked. The battery should be replaced if a cranking complaint exists and the battery has a yellow or clear hydrometer.

AUXILIARY CAMPER BATTERY (GAS ENGINE VEHICLES)

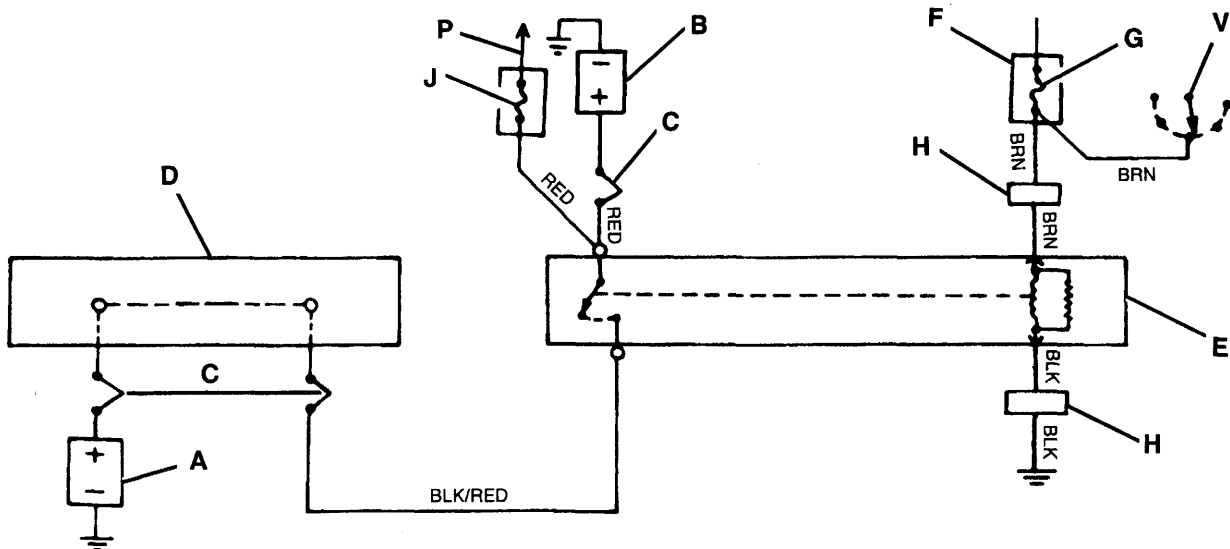
DESCRIPTION

An auxiliary battery is available for pickup models.

The auxiliary battery mounts to the left front of the engine compartment and is connected through a relay on the left wheelwell to the battery junction block on the right side of the cowl in the engine compartment. The relay is activated and grounded through the convenience center located on the left side of the cab behind the instrument panel.

OPERATION

Circuit operation is shown in figure 6. Constant voltage is supplied from the main battery (A) through the junction block (D) and the black/red wire to the relay.



- A. BATTERY
- B. BATTERY, AUXILIARY
- C. LINK, FUSIBLE
- D. BLOCK, JUNCTION (HOT AT ALL TIMES)
- E. RELAY, AUXILIARY
- F. BLOCK, FUSE
- G. FUSE, A/C HEATER — HOT IN RUN
- H. CENTER, CONVENIENCE
- J. FUSE, IN-LINE
- P. WIRE, CAMPER FEED
- V. SWITCH, IGNITION — RUN POSITION

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Figure 6—Auxiliary Battery Schematic

Constant voltage is also supplied by the auxiliary battery (B) to the relay and through the red feed wire (P) to the camper. When the ignition switch is turned to RUN, current flows through the heater/air conditioning fuse in the fuse block, through the convenience center, and across the coil in the relay. The relay energizes and the contacts close. The auxiliary battery can now be charged by the vehicle's charging system.

If voltage is not reaching the camper unit feed wire (P), check the following:

1. Auxiliary battery (B) state of charge.
2. Battery and convenience center (H) ground wires.
3. Heater fuse (G) by operating the heater or A/C with the engine running.
4. Fusible links (C).
5. Feed wire in-line fuse (J).

DIAGNOSIS OF THE BATTERY

CAUTION: Refer to "Caution" on page 6D1-1, and to the safety precautions in figure 3.

BATTERY TESTING

Refer to Figures 2, 3, 4, and 5

Tools Required:

GM P/N 12303040 (or equivalent) Battery Terminal Adapters

J 39200 Digital Multimeter

The following procedure should be used for testing batteries (figure 3):

1. VISUAL INSPECTION

- Check for obvious damage, such as a cracked or broken case or cover, that could permit loss of electrolyte. If obvious damage is noted, replace the battery. Determine the cause of the damage and correct as needed. If not, proceed to step 2.

2. HYDROMETER CHECK (figure 4)

A. GREEN DOT VISIBLE - Go to step 3

B. DARK; GREEN DOT NOT VISIBLE

- Charge the battery as outlined under "Battery Charging," then proceed to step 3.

C. CLEAR OR YELLOW

- If the hydrometer is clear or light yellow, the battery is low on electrolyte and should be replaced.

3. LOAD TEST

- Load testing requires the use of battery side terminal adapters (figure 5), (GM P/N 12303040 or equivalent) to ensure good connections. Do not load test a frozen battery. Replace it instead.

A. Use J 39200 digital multimeter to measure voltage across the terminals. With all loads off, and the green dot showing in the hydrometer, volt-

age should be 12 volts or higher. Unless the battery has just been discharged (such as by load test or cranking the engine), replace the battery if the voltage is below 12 volts.

B. With J 39200 still attached, connect a battery load tester across the battery terminals.

C. If the battery has been charging, apply a 300 ampere load for 15 seconds to remove the surface charge from the battery. Remove load. (Do not complete this step if the battery has not been recently charged.)

D. Wait 15 seconds to let the battery recover. Apply the specified load located on the battery label or listed in "Specifications." Read the voltage after 15 seconds, then remove the load.

E. If the voltage does not drop below the minimum value listed in figure 7, the battery is good and should be returned to service. (The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the proceeding few hours.)

F. If voltage drops below the minimum value listed, replace the battery.

BATTERY ELECTRICAL DRAIN

If the vehicle exhibits a low or dead battery after an overnight period, or goes down over a period of 2 or 3 days, the electrical system should be checked for an excessive electrical drain. This is referred to as "parasitic current drain."

If a battery needs recharging and no cause is evident, check the vehicle for excessive parasitic current drain.

One or more on-board solid state control modules, such as the PCM, may, at some time, exhibit a failure mode that causes a high parasitic drain on the vehicle's battery. When the battery is disconnected to install an ammeter, etc., the excessive current drain may not occur once circuit continuity is restored. Even though cycling the ignition key to the RUN and then to the OFF position may at times cause such a drain to recur, there may be drains that will not recur unless the vehicle systems are reactivated in a road test. Since the ignition switch must not be rotated to the ACCESSORY, RUN, or START position with an ammeter installed between the battery terminal and the battery cable, a current drain test tool must be used as described in the following procedures.

Before starting this procedure, make sure the ignition switch is in the "LOCK" position, all electrical accessories are turned off, and the doors are closed.

ESTIMATED TEMPERATURE	MINIMUM VOLTAGE
70° F. (21° C.)	9.6
50° F. (10° C.)	9.4
30° F. (0° C.)	9.1
15° F. (-10° C.)	8.8
0° F. (-18° C.)	8.5
0° F. (BELOW -18° C.)	8.0
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Figure 7—Battery Temperature VS. Voltage Drop

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CURRENT DRAIN TEST

Tools Required:

- Terminal Adapters (GM P/N 12303040)
- J 38758 Parasitic Draw Test Switch
- J 39200 Digital Multimeter

NOTICE: The parasitic draw test switch should never be turned to the "OFF" position with the engine running or damage could occur to the vehicle electrical system.

1. Remove the negative battery cable at the main battery.
 - The main battery will be wired from the positive battery terminal to the starter motor.
2. Install the male end of J 38758 to the negative battery terminal (figure 8).
3. Turn the knob on the test switch to the "OFF" position.
4. Install the negative battery cable to the female end of the test switch.
5. Turn the test switch to the "ON" position.
6. Road test the vehicle while activating all accessories, such as the radio and air conditioning.
7. Turn the ignition switch to the "OFF" position and remove the key.

! Important

- From this point on, electrical continuity must be maintained in the ground circuit to the battery, either through the J 38758 (in the "ON" position) or through the ammeter.
8. Some components, such as PCM's, have timers that draw several amps of current while they cycle down. This can give a false parasitic drain reading. Wait 15 minutes for these components to power down before continuing this test.

! Important

- Before performing step 9, if a digital multimeter is being used other than J 39200, make sure the vehicle does not have a high current drain that might damage the multimeter when it is installed. This can be done using the following procedure.

- Connect a jumper wire with an in-line 10-amp fuse to the terminals on the test switch. Then turn the test switch to the "OFF" position. Wait about 10 seconds. If the fuse does not blow, current draw is less than 10 amps, and the digital multimeter can be used safely. Before removing the fused jumper wire and installing the multimeter, turn the test switch to the "ON" position.

9. Set the multimeter to the 10-amp scale and connect it to the terminals on the test switch.
10. Turn the test switch to the "OFF" position to allow current to flow through the meter.
11. Wait at least 60 seconds. Check the current reading. If the current reading is at or below two amps, turn the test switch to the "ON" position (to maintain continuity in the electrical system) and switch down to the two amp scale for a more accurate reading when the test switch is reopened.
12. Take the reading in milliamps if possible.
13. Find the reserve capacity of the battery in "Specifications" at the end of this section. Divide this number by 4. Compare this to the digital multimeter reading. The current drain reading should not exceed this number. (Example: If a battery has a reserve capacity of 100 minutes, the current drain should not exceed 25 milliamps). If the vehicle has a diesel engine with 2 batteries, add the reserve capacities together and divide this total by four. If a vehicle is equipped with an auxiliary battery, use only the reserve capacity of the main battery.

NOTICE: Always turn the test switch knob to the "ON" position before removing each fuse to maintain continuity in the electrical system and to avoid damaging the meter due to accidental overloading, such as opening a door to change a fuse.

14. If current draw is too high, remove system fuses one at a time until the draw returns to a value less than or equal to the specifications. Start with fuses that are hot at all times. Refer to the electrical

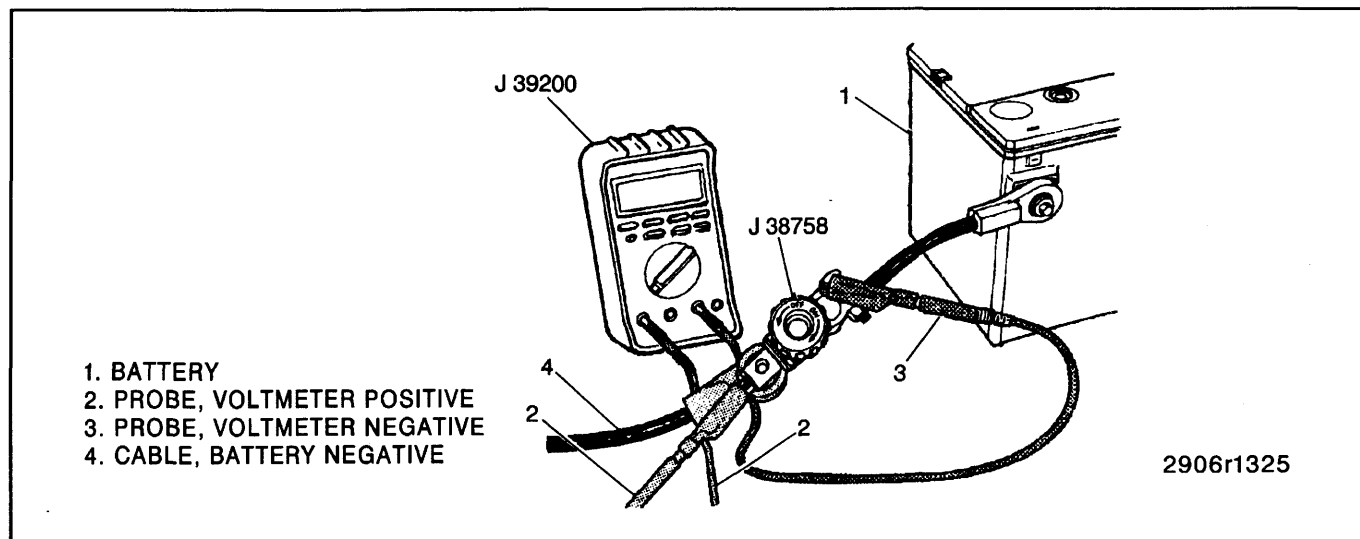


Figure 8—Parasitic Draw Test Switch Installed

diagrams and diagnosis section of NATP-9442. To remove the fuse, you must first open the door. This may cause a high enough current draw to damage the multimeter. To protect the meter without disrupting electrical continuity, turn the test tool to the "ON" position before opening the door. Then remove the courtesy lamp fuse. Note the meter reading. If the parasitic load is still excessive, start removing the other fuses, one at a time. Leave the courtesy lamp fuse out during diagnosis so the vehicle door can be left open.

Perform steps 10 through 12 each time a fuse is removed.

15. Removing the PCM fuse should cause a drop of less than 10 milliamps.

- If the drop is more than 10 milliamps, check the orange wires for a short to ground. Also check the components connected to the orange wires. Refer to the electrical diagrams and diagnosis section of NATP-9442.

- If there is no drop in the milliamp reading, the PCM is not drawing current. Refer to the electrical diagrams and diagnosis section of NATP-9442.

16. Repeat the parasitic current drain procedure after any repair has been completed.

17. When the cause of excessive current draw has been located and repaired, remove the meter, test switch, and terminal adapters and connect the negative battery cable to the negative battery terminal.

NOTICE: Refer to "Notice" on page 6D1-1.



Tighten

- Negative battery cable bolt to 15 N.m (11 lbs. ft.).

ON-VEHICLE SERVICE

CAUTION: Refer to "Caution" on page 6D1-1, and to the safety precautions in figure 3.

BATTERY CHARGING

Refer to Figures 2, 3, 4, and 5

When it is necessary to charge the battery, the following basic rules must be followed (figure 3):

1. Use a charger with an end of charge voltage of 16.0 volts and equipped with a voltmeter that is accurate within 1 percent.
2. Ambient (surrounding) temperature should be 15° C to 38° C (60° F to 100° F). A battery that is extremely cold may not accept measurable current for several hours after starting the charger.
3. Charging area should be well ventilated.
4. Do not charge the battery if the built-in hydrometer is clear or light yellow. If cranking problems exist, replace the battery.
5. Do not charge a battery if it seems to be frozen. Replace it.
6. Batteries with a green dot showing in the hydrometer do not require charging unless they have just been discharged (such as cranking the vehicle).

CHARGING PROCEDURE

CAUTION: Always turn off the ignition switch when connecting or disconnecting battery cables, battery chargers, or jumper cables. Failure to do so may result in personal injury and damage to the powertrain control module or other electronic components.

When charging the battery in the vehicle, proceed to step 1. If charging side terminal batteries out of the vehicle, install an adapter kit (GM P/N 12303040 or equivalent) (figure 5).

The adapters should be tightened against the lead terminals of the battery to keep resistance between the adapter and the battery terminals to a minimum.

1. Make sure all charger connections are clean and tight.
2. Charge the battery using the charger setting for 12-volt batteries that gives the highest charge rate to the battery until the green dot appears. (Do not use charger settings for jump-starting vehicles to charge the battery. Refer to the charger manufacturer's instructions). The battery should be checked periodically while charging. Tap the hydrometer lightly on the top to dislodge any air bubbles that may prevent a correct indication.
3. If the battery feels hot 52° C (125° F), or if violent gassing or spewing of electrolyte through the vent holes occurs, discontinue charging or reduce the charging rate.
4. After charging, the battery should be tested as outlined in "Diagnosis of the Battery."

CHARGING TIME REQUIRED

The time required to charge a battery will vary depending upon the following factors:

- A. Size of the Battery - A completely discharged heavy-duty battery requires more than twice the recharging time as a completely discharged light-duty battery.
- B. Temperature - The colder the battery, the more time it takes to recharge. When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. In time the battery will accept a higher rate as the battery warms.
- C. Charger Capacity - The higher the charger amperage, the less time it will take to charge the battery.
- D. State-Of-Charge - A completely discharged battery requires more than twice as much charge as a

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one-half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, charging current will also increase.

Any battery discharged by parasitic current drain, and then allowed to stand in this condition for a period of time, may not accept a charge readily. However, if recharged long enough, many batteries will return to a usable condition.

If the battery remains in an extremely discharged condition for a prolonged period, it can become permanently damaged. This damage can be accelerated by changes in temperatures. Batteries that are extremely discharged can freeze at temperatures as high as -7°C (20°F) and be permanently damaged.

To prevent battery damage and recharge problems, vehicles that are not going to be in service within a 30 day period should have the negative battery cable disconnected to remove the constant drain on the battery. If this is not possible, recharge the battery periodically every 30-45 days until the green dot is visible.

CHARGING A VERY LOW OR COMPLETELY DISCHARGED BATTERY

The following procedure should be used to recharge a very low or completely discharged battery. Unless the procedure is properly followed, a perfectly good battery may be needlessly replaced.

1. Measure voltage at battery terminals with J 39200 digital multimeter. If voltage is below 11 volts, charge current will be very low and it could take some time before it accepts current in excess of a few milliamperes.
2. Set the battery charger on the high setting.
3. Some chargers feature polarity protection circuitry that prevents charging unless the charger leads are connected to the battery terminals correctly. A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer's instructions telling how to bypass or override the circuitry so the charger will turn on and charge a low-voltage battery.
4. Battery chargers vary in the amount of voltage and current they provide. The time required for the battery to accept measurable charger current at various voltages may be as follows:
 - 16.0 volts or more up to 4 hours
 - 14.0 to 15.9 volts up to 8 hours
 - 13.9 volts or less up to 16 hours

Important

- If the charge current is **not** measurable at the end of the above charging times, replace the battery.

- If the charge current **is** measurable during the charging time, the battery is considered to be good. Complete the charging in the normal manner.

5. It is critical to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore it to a useable state. As a rule of thumb, use the reserve capacity rating of the battery to determine how long it will take to completely recharge the battery. For capacity ratings, refer to "Specifications." Divide the reserve capacity rating by the amount of ampere charge to determine how many hours of charging are needed. (Rating divided by amps = hours.)

- For example: a battery with a reserve capacity rating of 75, charged at a rate of 10 amperes, will take 7.5 hours to fully recharge (75 divided by 10 = 7.5). The same battery, charged at a rate of 25 amperes, will take 3 hours to fully recharge (75 divided by 25 = 3).

6. Any battery recharged by this procedure should be load tested to determine serviceability. Refer to "Diagnosis of the Battery."

JUMP STARTING IN CASE OF EMERGENCY

Do not try to jump start a vehicle if you are unsure of the other vehicle's voltage or ground, or if the other vehicle's voltage and ground are different.

Diesel engine vehicles have more than one battery. Should the vehicle have an optional diesel engine or an auxiliary battery option, use only the battery on the passenger side of the vehicle.

This procedure can be used to start a single-battery vehicle from any of the diesel engine vehicle's batteries. However, at low temperatures, it may not be possible to start a diesel engine vehicle from a single battery in another vehicle.

The booster battery and discharged battery should be treated carefully when using jumper cables. Follow the procedure outlined below, being careful not to cause sparks.

CAUTION: Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- Always shield your eyes and avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow battery acid to contact the eyes or skin. Flush any contacted areas with water immediately and thoroughly, and get medical help.
- Follow each step in the jump starting instructions.

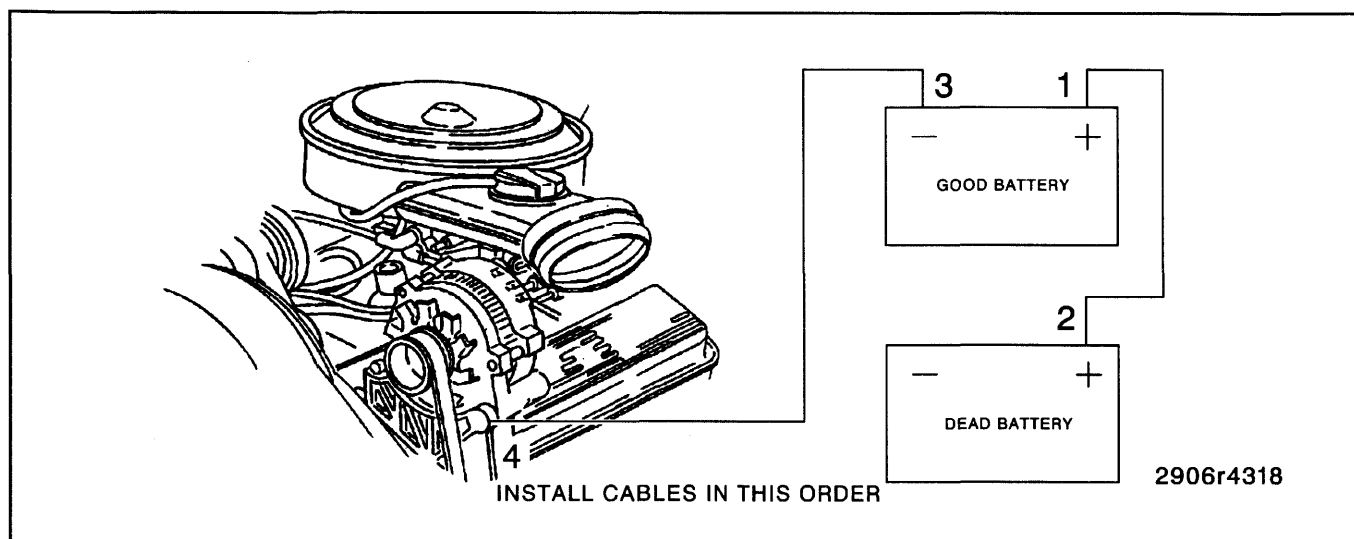


Figure 9—Installing Jumper Cables

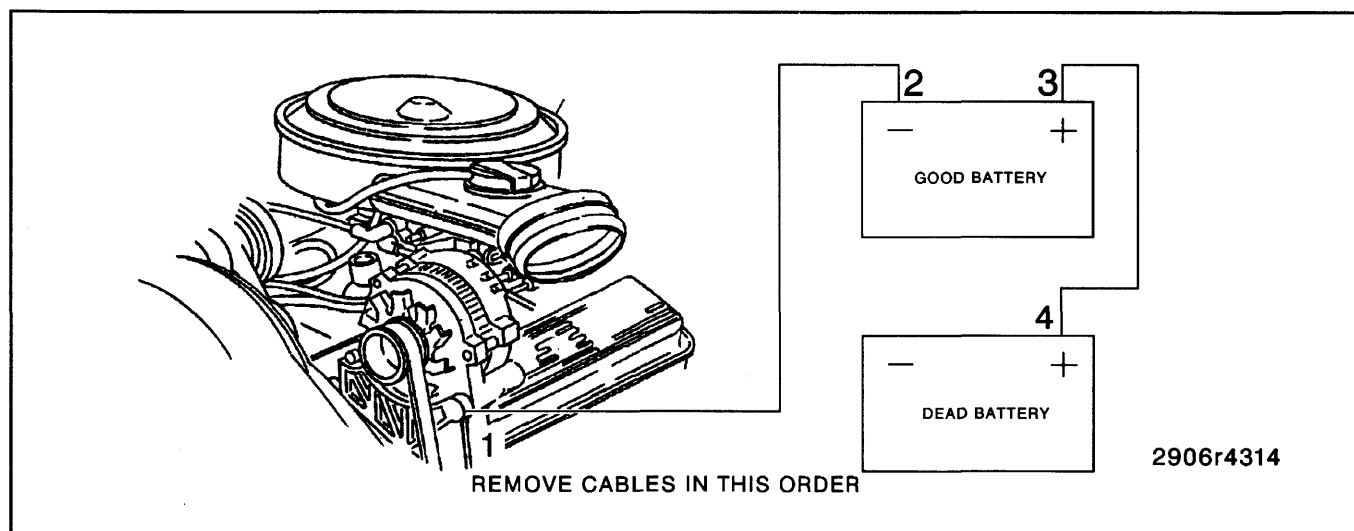


Figure 10—Removing Jumper Cables

NOTICE: Do not push or tow the vehicle to start it. Under some conditions this may damage the catalytic converter or other parts of the vehicle. Also, since this vehicle has a 12-volt negative ground electrical system, make sure the vehicle or equipment used to jump start the engine has a 12 volt negative ground electrical system. Use of any other type system may damage the vehicle's electrical components.

JUMP STARTING PROCEDURE

1. Position the vehicle with the good (charged) battery so that the jumper cables will reach, but NEVER let the vehicles touch. Also, make sure the jumper cables do not have loose or missing insulation.
2. Set the parking brake and place the transmission in neutral. Block the wheels. Turn off the ignition switch, lights, and all other electrical loads that aren't needed except for the hazard flasher or any lamps needed for the work area.
3. Check the built-in hydrometer. If it is clear or light yellow, do not attempt to jump start the battery. Replace it.
4. Attach the end of one jumper cable to the positive terminal of the booster battery and the other end of the same cable to the positive terminal of the discharged battery (figure 9).
5. Attach one end of the remaining negative jumper cable to the negative terminal of the booster battery.
6. Make the final connection of the negative cable to a solid ground (such as an A/C compressor bracket), at least 450 mm (18 inches) from the battery of the vehicle being started (figure 9).
7. Start the engine of the vehicle that is providing the jump start and turn off all electrical accessories. Then start the engine in the vehicle with the discharged battery.
8. Reverse steps 4, 5, and 6 exactly when removing the jumper cables. The negative cable must be disconnected from the engine that was jump started first (figure 10).

BATTERY REPLACEMENT

↔ Remove or Disconnect (Figures 11 and 12)

1. Negative cable from the negative battery terminal.
2. Positive cable from the positive battery terminal.
3. Battery hold-down retainer.
4. Battery.

👁 Inspect

1. Battery for damage.
 2. Cables and connectors for corrosion or wear.
 3. Carrier for damage or foreign objects.
- If damage is noted, find and correct the cause.

↔ Install or Connect (Figures 11 and 12)

NOTICE: For steps 2, 3, and 4, refer to "Notice" on page 6D1-1.

1. Battery into cleaned carrier.
2. Hold-down retainer.

🔧 Tighten

- Retainer bolt to 15 N.m (11 lbs. ft.).
3. Positive cable and positive battery terminal to the battery.
 4. Negative cable and negative battery terminal to the battery.

🔧 Tighten

- Side terminals to 15 N.m (11 lbs. ft.).

BATTERY CABLES

Excessive resistance caused by poor terminal connections and partial short circuits through worn cable insulation will result in an abnormal voltage drop in the starter cable. Low voltage at the starter will prevent normal starter operation and cause hard starting.

Whenever battery cables are replaced, always use a replacement cable that is the same type, diameter, and length. Some positive cables have additional feed wires attached to them and some negative cables have additional ground leads attached.

Always be certain when replacing a battery cable to route it the same as the original cable.

NOTICE: When installing the positive battery cable to starter solenoid, the inner nut on the solenoid battery terminal must be tightened before the battery cable and other leads are installed. Failure to do so will result in solenoid terminal and/or solenoid damage.

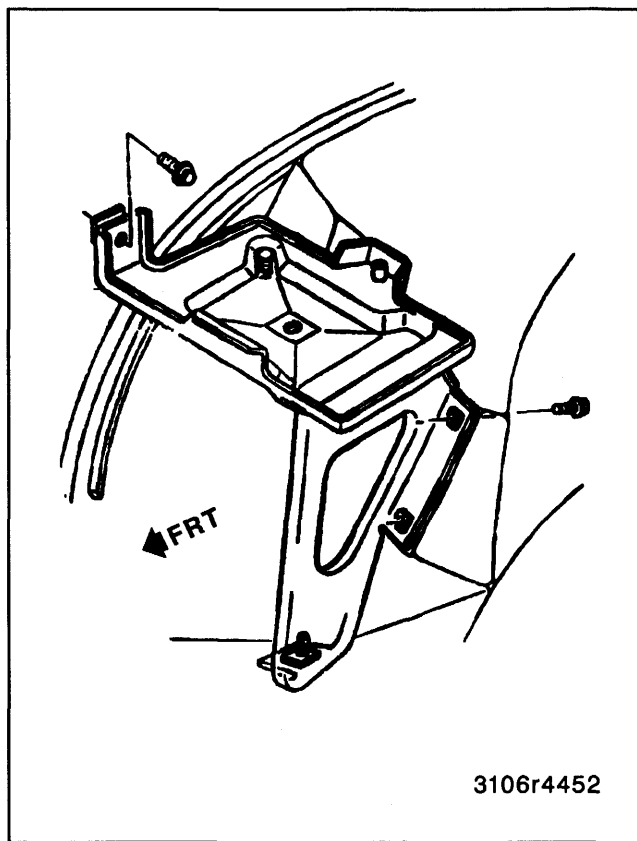


Figure 11—Battery Tray

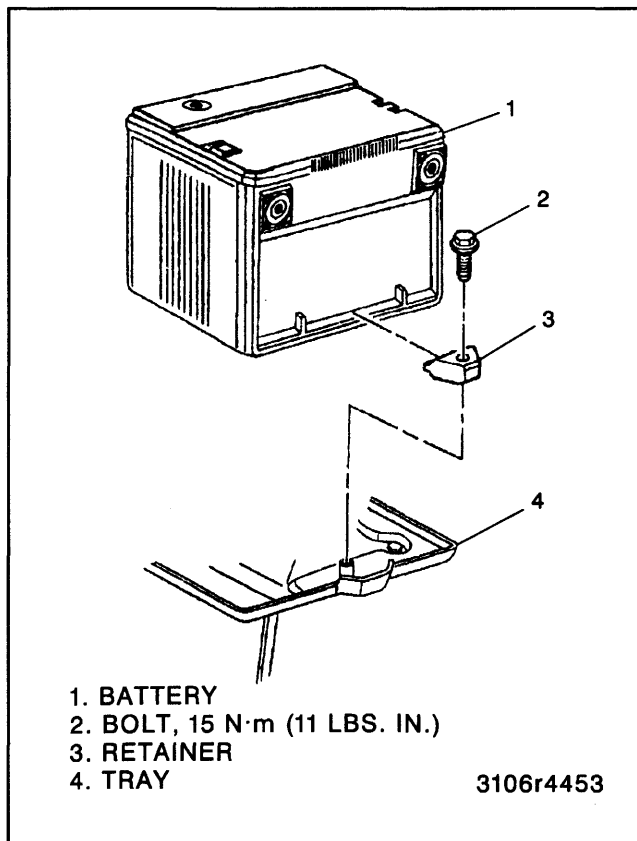


Figure 12—Battery Retainer

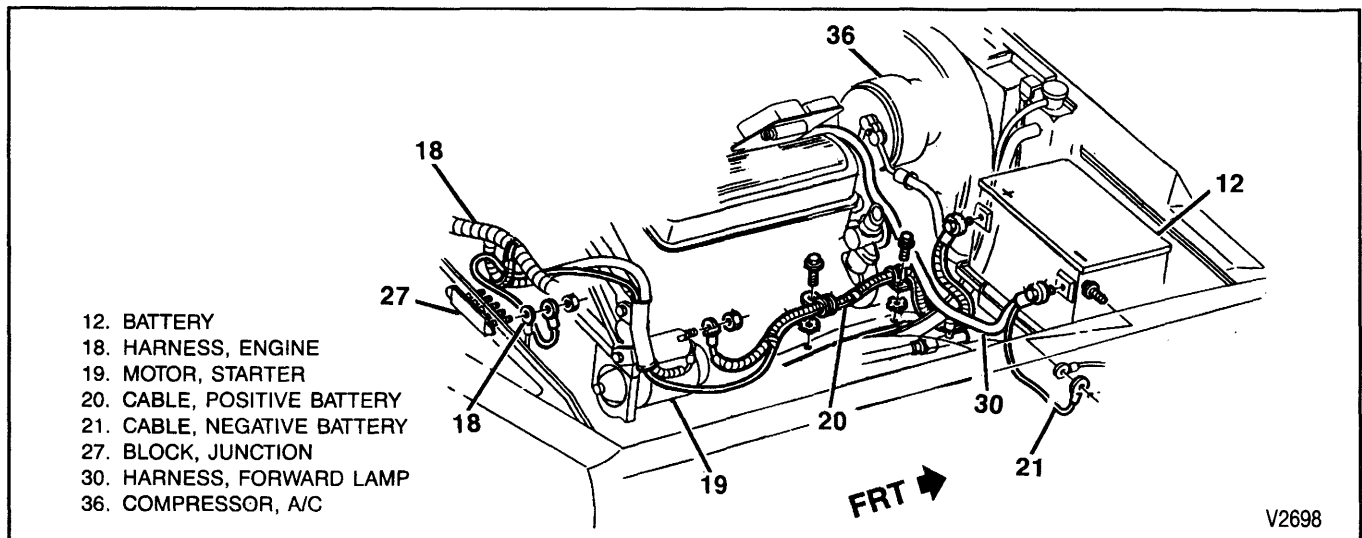


Figure 13—Battery Cable Routing (Gas Engines)

CAUTION: To prevent possible personal injury from a moving vehicle or operating engine do the following before performing the checks:

1. Engage the parking brakes and block the wheels.
2. Place the manual transmission in the neutral position or the automatic transmission in park.
3. On gas engines, disconnect the battery feed at the distributor. On diesel engines, disconnect the battery feed at the engine shutoff (ESO) solenoid.
4. Check the voltage drop between the positive battery terminal and starter terminal stud with the starter operating.
5. Check the voltage drop between the starter housing and the frame with the starter operating.
6. If the voltage drop in any of the above is more than 0.5 volt, there is excessive resistance in the circuit. To eliminate resistance, the cables should be disconnected and connections cleaned. If cables are frayed or the clamps corroded, the cables should be replaced. When selecting new cables, be sure they are the same length and diameter as the ones being replaced. Battery cable routing is shown in figures 13 through 16.

GROUND STRAPS

Additional ground straps are used to connect the body and frame to the engine and transmission. Always connect all ground straps to ensure a good ground path to the battery from all electrical components. For illustrations and ground strap locations, refer to SECTION 6D5.

6D1-12 BATTERY

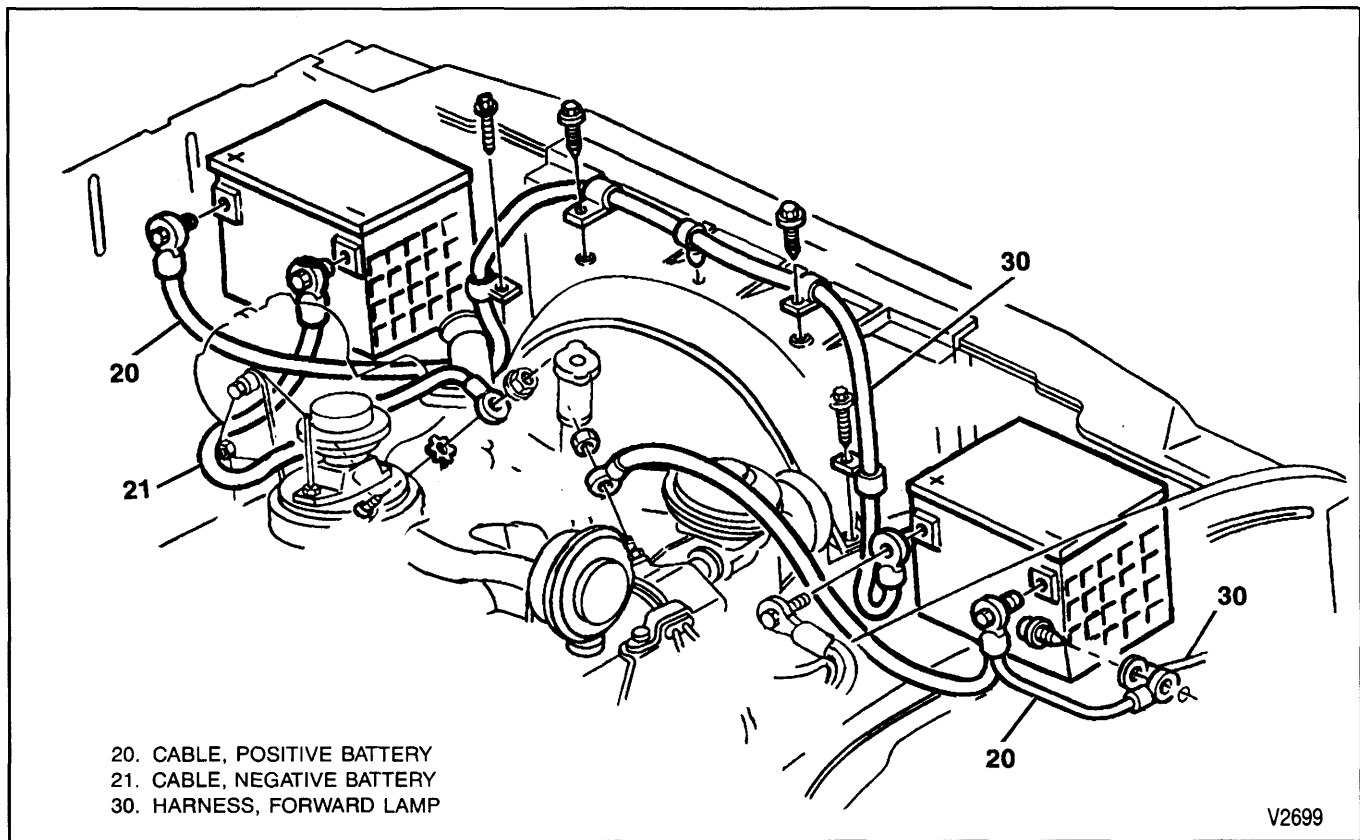


Figure 14—Battery Cable Routing (Diesel Engines, 6.5L VIN P, and 6.5L VIN S)

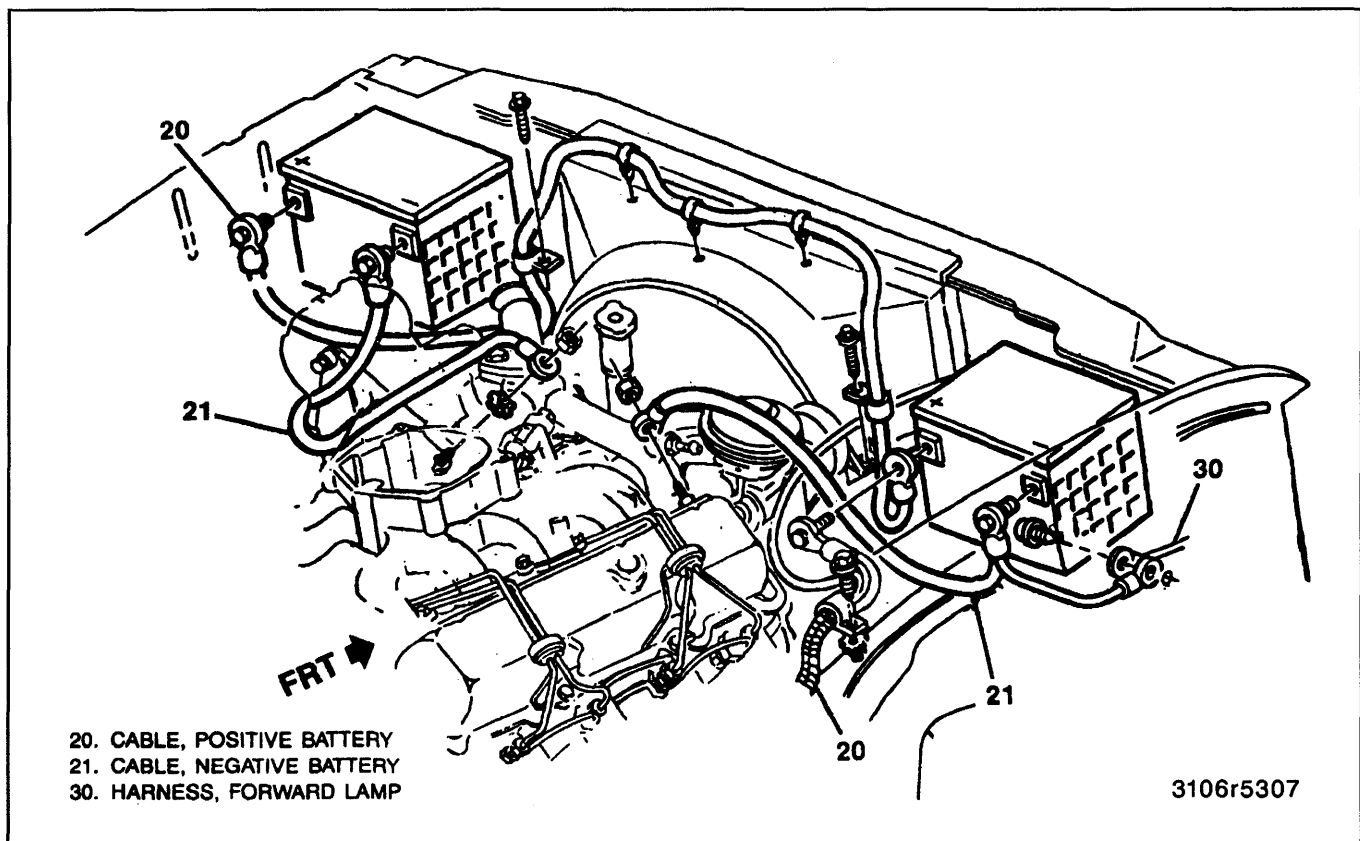


Figure 15—Battery Cable Routing (6.5L VIN F)

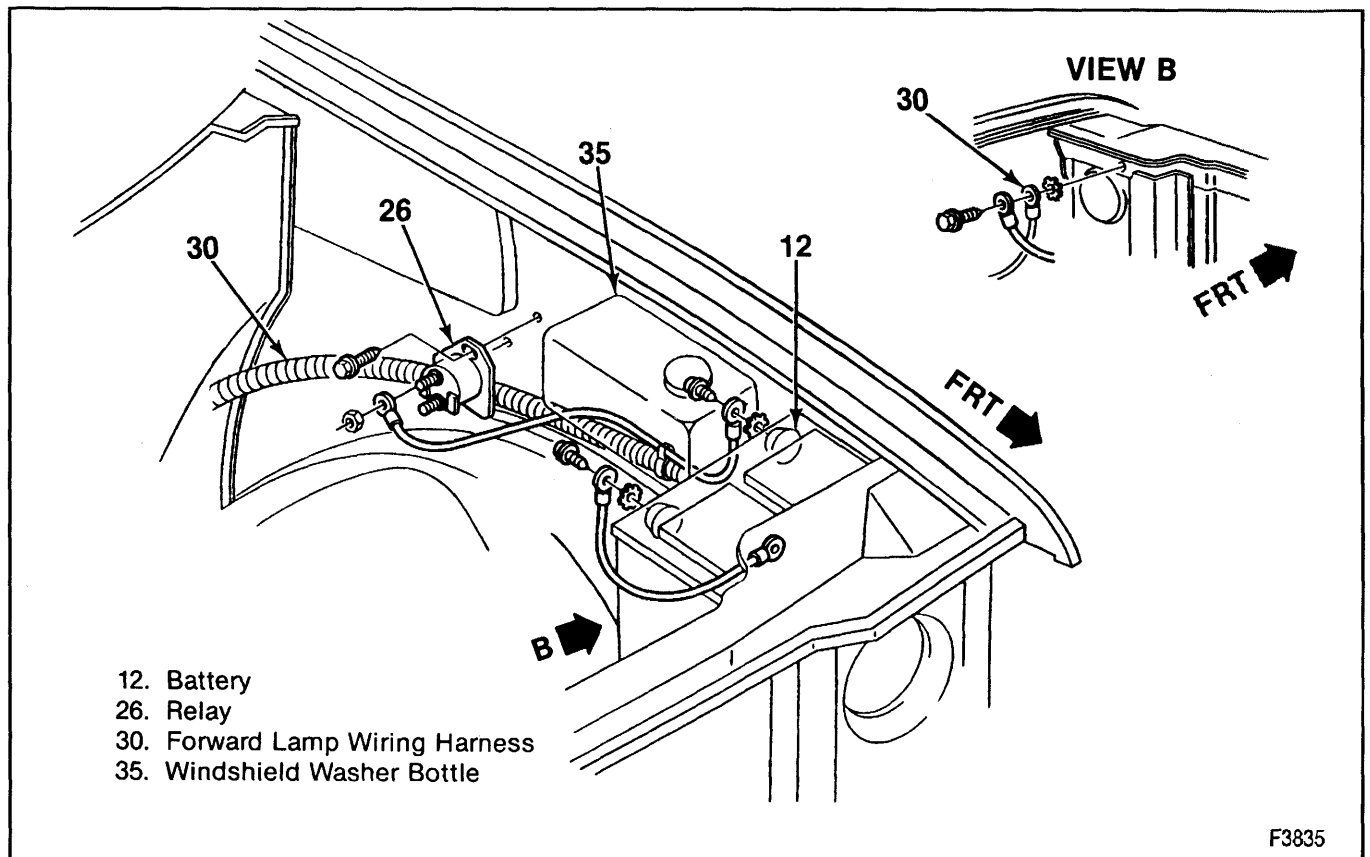


Figure 16—Auxiliary Battery, Relay, and Wiring

6D1-14 BATTERY

SPECIFICATIONS
BATTERY

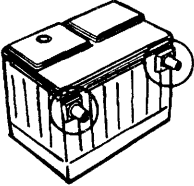
Catalog Number	Application	Catalog Replacement Number	Volts	Cold Cranking Amperes Rating @ -18° (0°F)	Reserve Capacity (Minutes at 25 Amps)	Load Test (Amperes)
1983744	All	78A-72	12	600	115	300

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Lbs. Ft.
Battery		
Retainer Nut	17	13
Terminals	15	11
		T2080

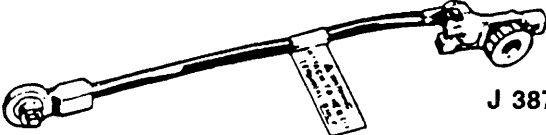
SPECIAL TOOLS

1.



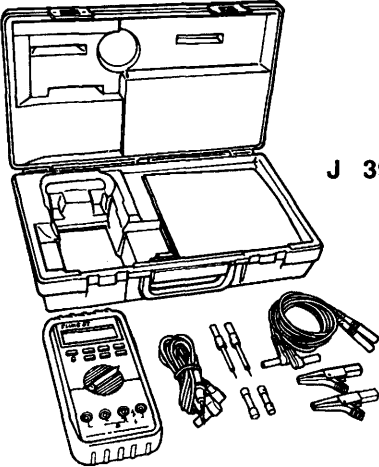
S/T ADAPTERS

2.



J 38758

3.



J 39200

1. BATTERY TERMINAL ADAPTERS—GM P/N 12303040

2. CURRENT DRAIN TOOL

3. MULTIMETER

V1331

SECTION 6D2

CRANKING SYSTEM

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

CRANKING CIRCUIT

The cranking circuit consists of the battery, starter motor, ignition switch (gasoline engines), engine control switch (diesel engines), neutral start switch (manual transmission), and related electrical wiring (figures 1 and 2).

For detailed schematics of the cranking system, refer to the electrical diagrams section of NATP-9442.

STARTER MOTOR

Four starter motors are used on these engines.

SD-260 and SD-300 are straight drive starters with the pinion driven directly by the armature shaft. Each has pole pieces arranged around the armature that are energized by wound field coils (figure 3). This type is used on gas engines.

The PG-260 achieves gear reduction at a ratio of 5:1 through planetary gears. It's relatively small size and light weight offers improved cranking performance and reduced current requirements for larger gasoline engines (figures 4 and 5).

The 28-MT, used on diesel engines, is a gear reduction starter with an overrunning roller type clutch and an enclosed shift lever (figures 6 and 7).

Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icing conditions, and splash.

Solenoid windings are energized when the ignition switch is in the start position. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear, the solenoid main contacts to close, and cranking takes place. When the engine

6D2-2 CRANKING SYSTEM

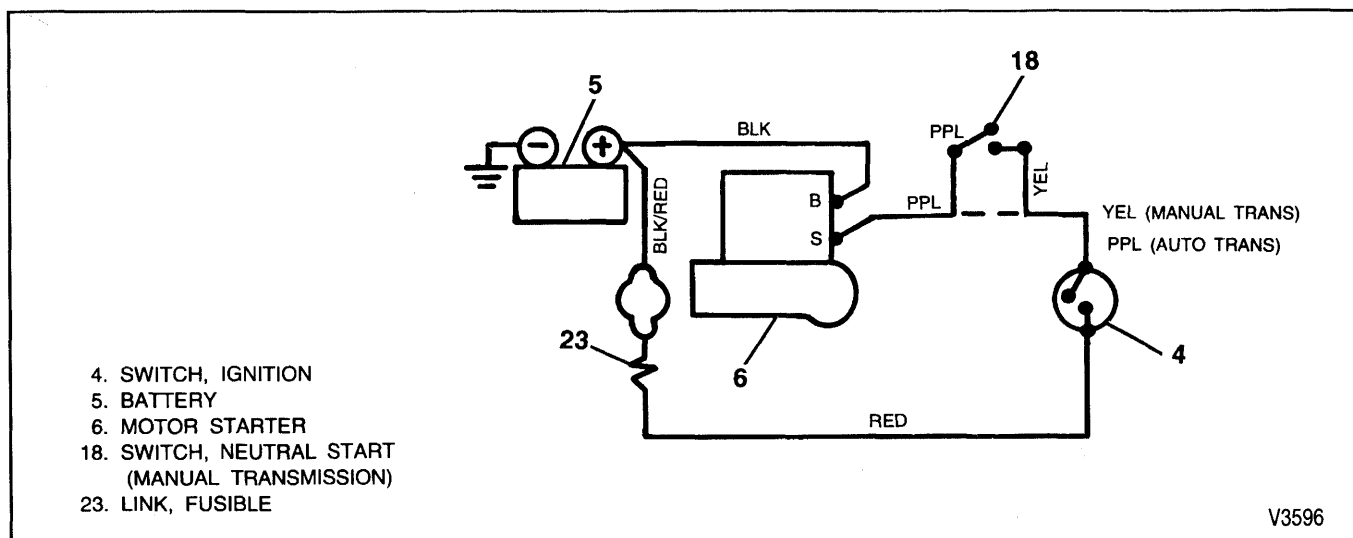


Figure 1—Cranking Circuit (Gas Engines)

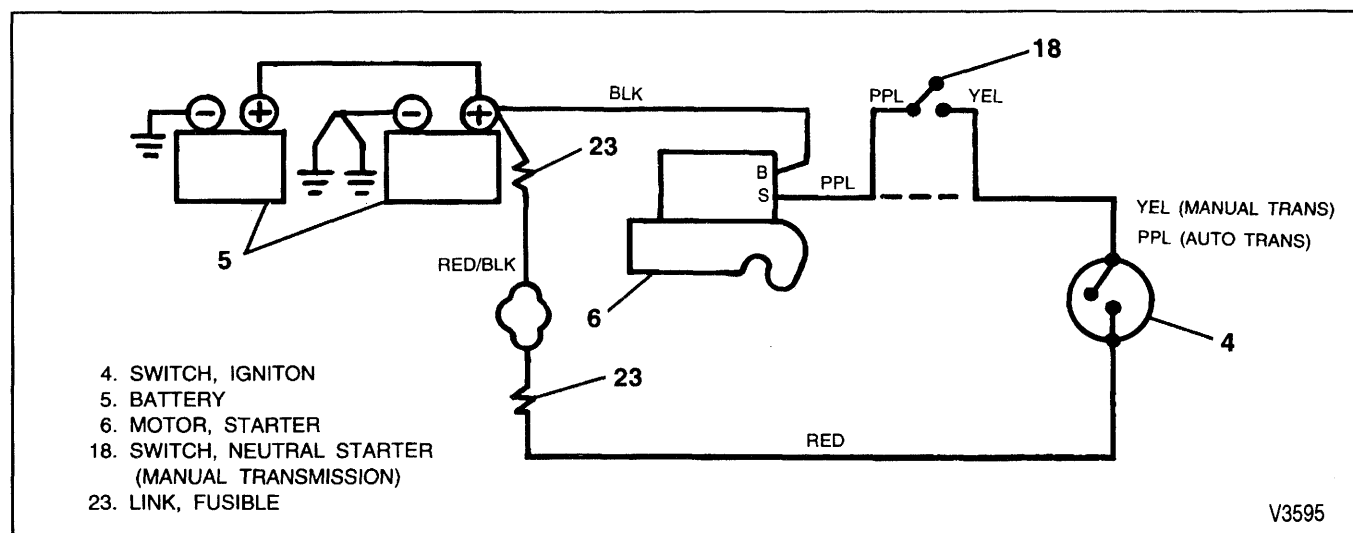


Figure 2—Cranking Circuit (Diesel Engine)

starts, the pinion overrunning clutch protects the armature from excessive speed until the ignition switch is released, at which time the plunger return spring causes the pinion to disengage. To prevent excessive overrunning, release the switch from the crank position as soon as the engine starts.

UNIT REPAIR INFORMATION

For bench repair of the SD-260, SD-300, or 28-MT starter motors, refer to the Light Duty Truck Unit Repair Manual.

PG-260 model starters are serviced by replacement only.

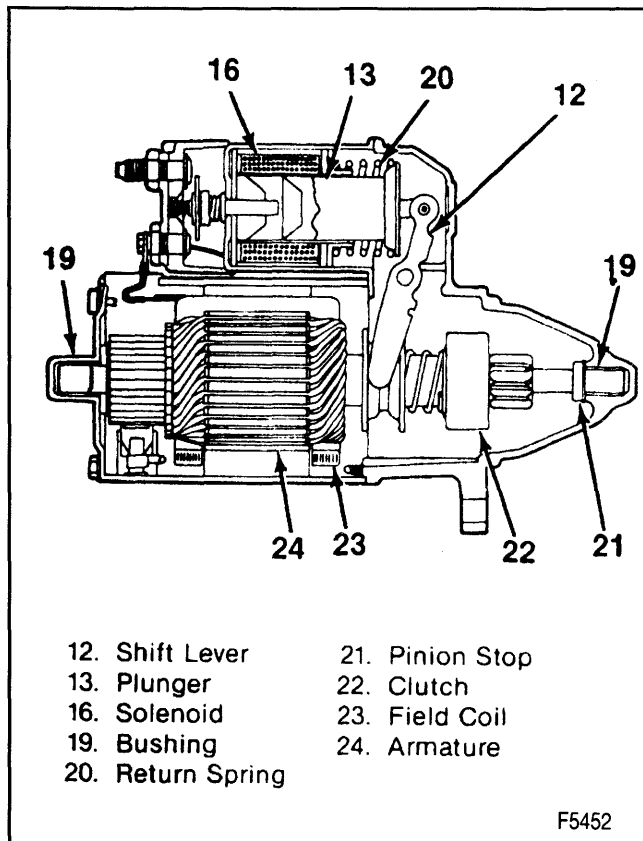


Figure 3—SD Series Starter Motor (Typical)

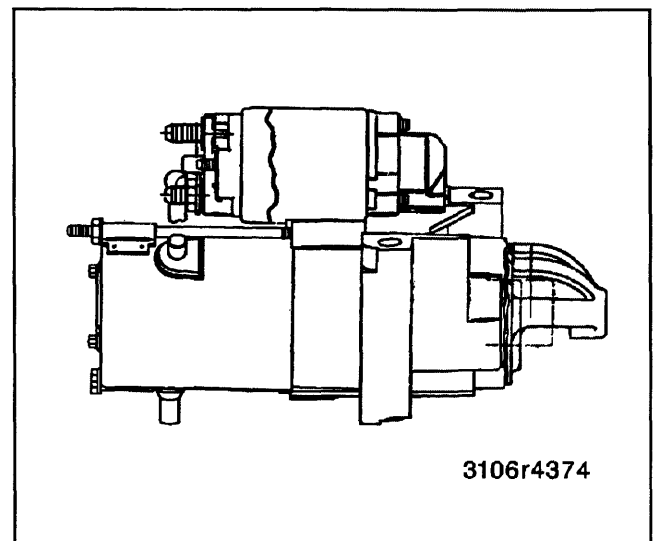


Figure 4—PG-260 Starter Motor

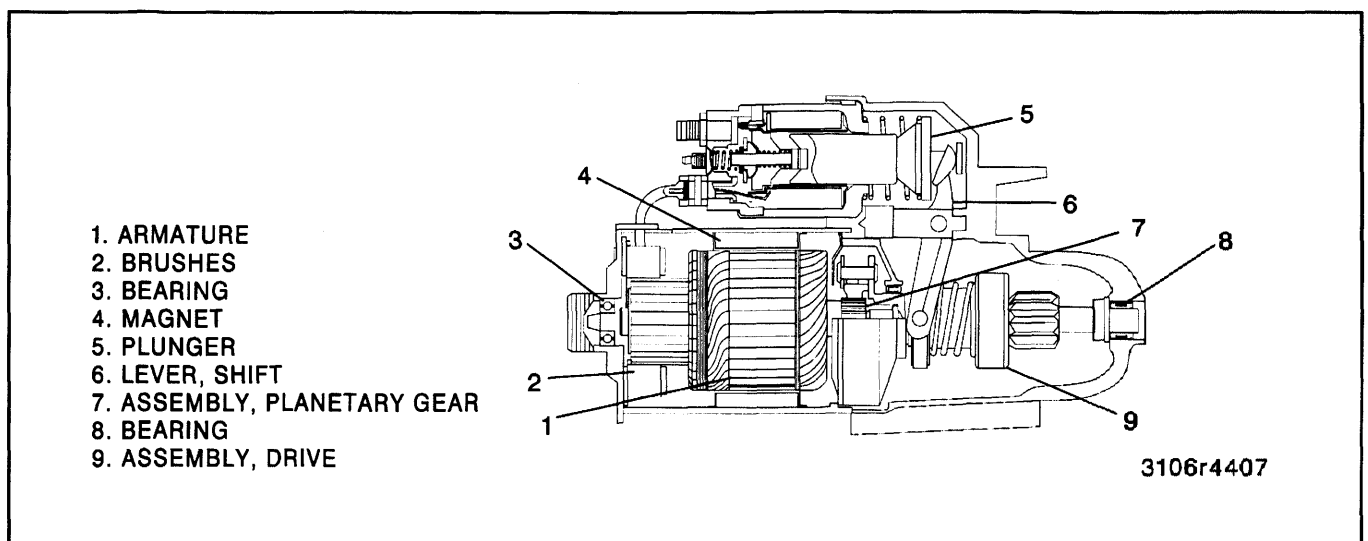


Figure 5—PG Series Components (Typical)

6D2-4 CRANKING SYSTEM

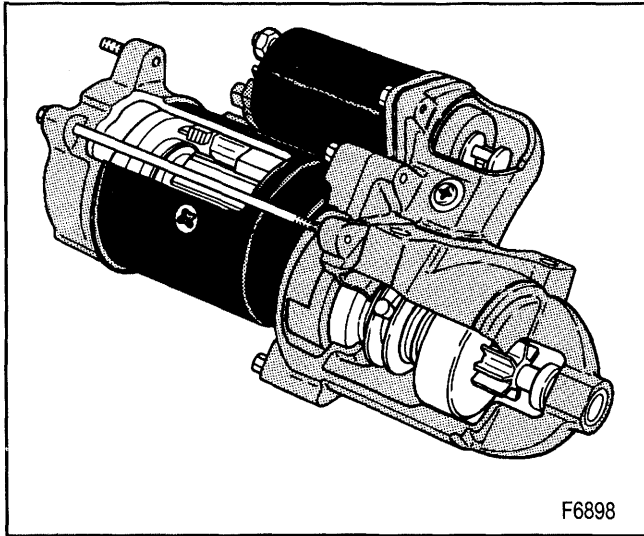


Figure 6—28-MT Starter Motor

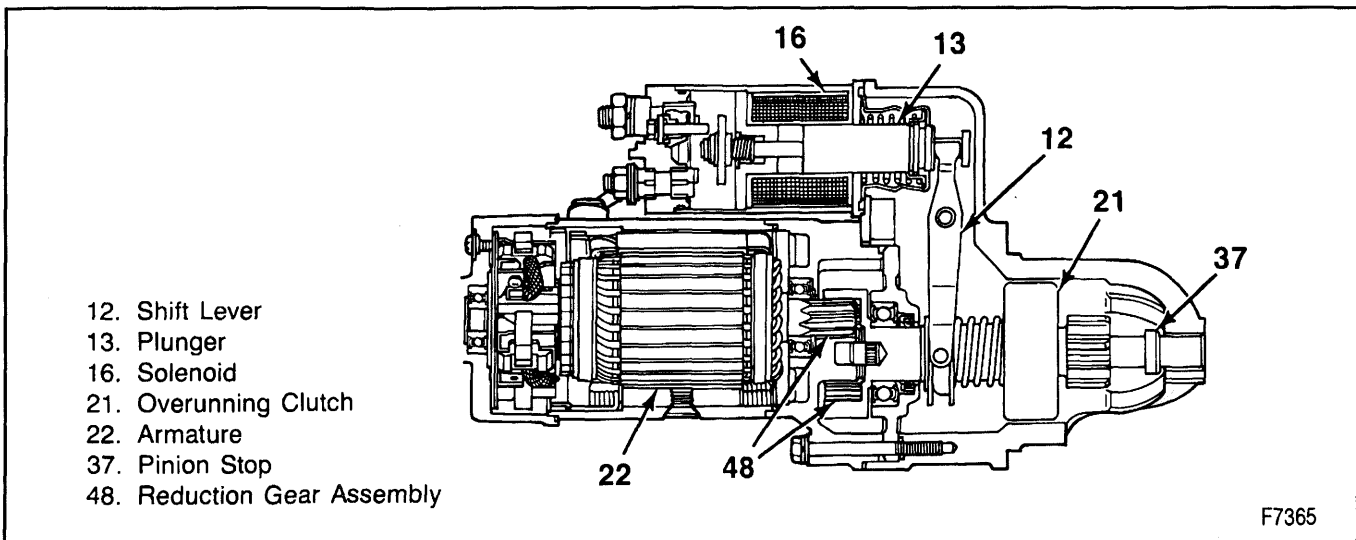


Figure 7—28-MT Series Components

DIAGNOSIS OF THE CRANKING SYSTEM

Refer to figures 8 and 9 for diagnosis of the cranking system. Before removing any component in the system for repair, make the following checks.

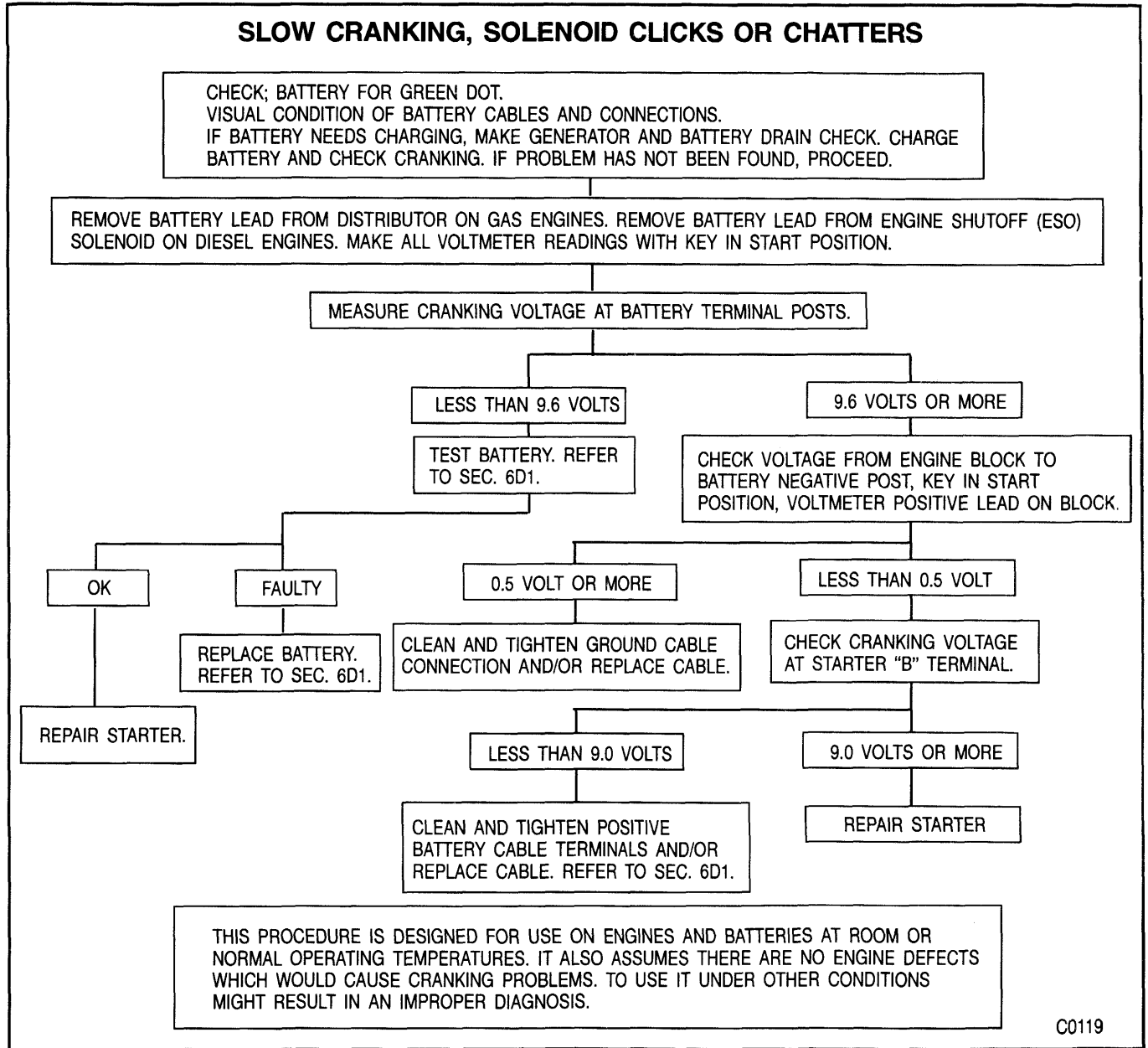
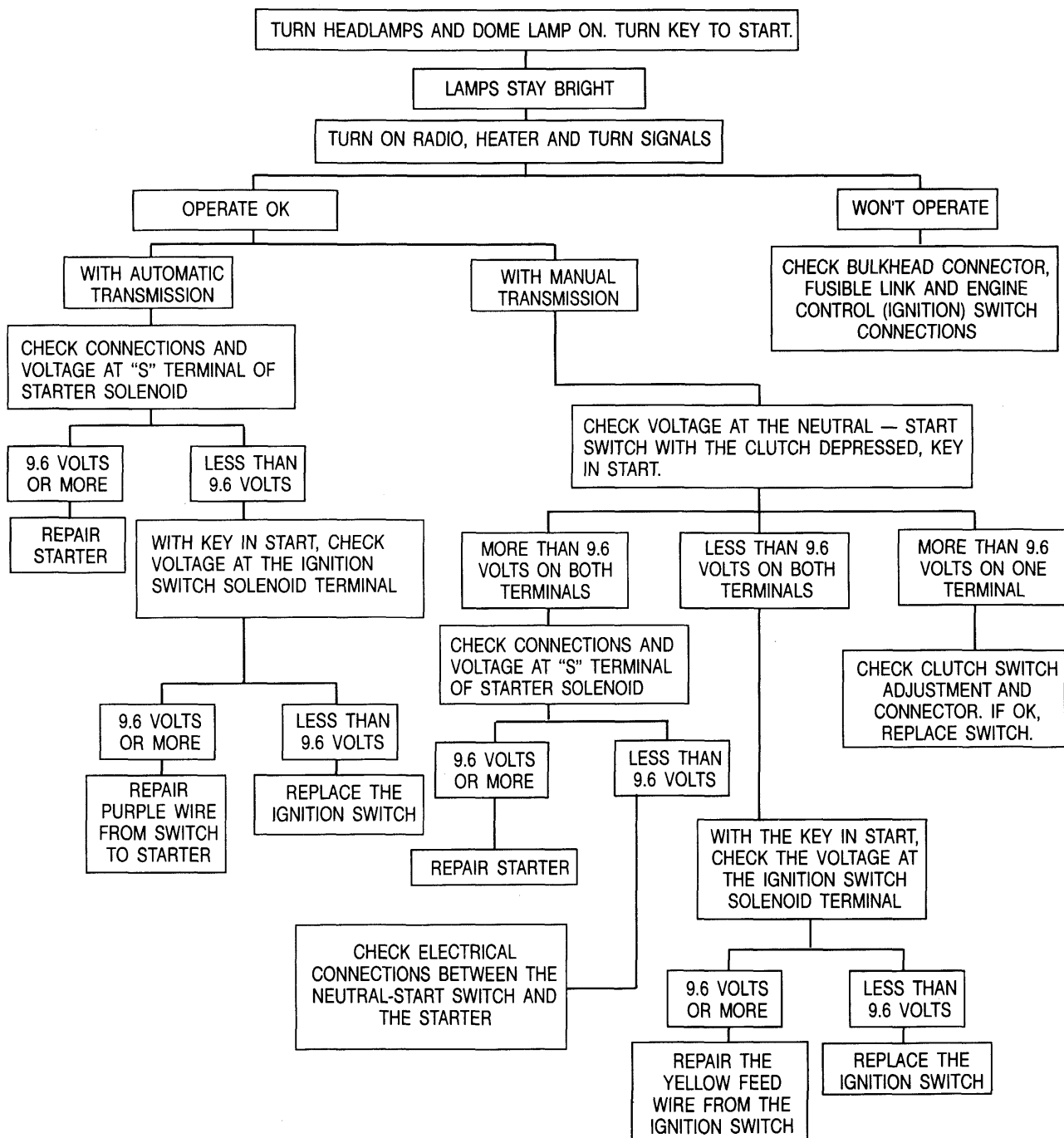


Figure 8—Cranking System Diagnosis (1 of 2)

6D2-6 CRANKING SYSTEM

NO CRANKING, NO SOUND FROM SOLENOID



C0182

Figure 9—Cranking System Diagnosis (2 of 2)

DIAGNOSIS OF STARTER MOTOR NOISE

PROBLEM	POSSIBLE CAUSE	CORRECTION
High-pitched whine during cranking (before engine fires) but engine cranks and fires normally.	Distance too great between the starter pinion and the flywheel.	Remove shims at the starter mount. Refer to "Starter Motor Noise".
High-pitched whine after the engine fires as key is being released. The engine cranks and fires normally. This complaint is often diagnosed as "starter hang-in" or "solenoid weak".	Distance too small between the starter pinion and the flywheel. Flywheel runout contributes to the intermittent nature of the problem.	Add shims at the starter mount. Refer to "Starter Motor Noise".
A loud "whoop" after the engine fires but while the starter is still held engaged. Sounds like a siren if the engine is revved while the starter is engaged.	Usually due to a worn starter motor clutch.	Remove the starter motor and check the clutch. Refer to the Light Duty Truck Unit Repair Manual.
A "rumble" "growl" or (in severe cases) a "knock" as the starter is coasting down to a stop after starting the engine.	Usually due to a bent or unbalanced starter armature.	Remove the starter motor and check the armature. Refer to the Light Duty Truck Unit Repair Manual.
D0134		

CRANKING CIRCUIT

BATTERY

Determine the condition of the battery. Refer to SECTION 6D1 for battery diagnosis and testing.

WIRING

Check the 5-amp CRANK fuse. Inspect the circuit for open circuits, loose terminals inside connectors, corrosion, and damage. Verify that no wires are pierced by screws and no harnesses are missing insulation by rubbing on components. Inspect all connections to the starter motor, solenoid, ignition (or engine control) switch, and battery, including all ground connections. Clean and tighten all connections as required.

SOLENOID AND CONTROL SWITCHES

Inspect all switches to determine their condition.

Vehicles equipped with manual transmissions have a neutral start switch attached to the clutch pedal that closes when the pedal is depressed. Vehicles with automatic transmissions have a mechanical interlock in the steering column that does not allow the ignition switch to turn to START unless the transmission is in PARK or NEUTRAL.

STARTER MOTOR NOISE

Refer to "Diagnosis of Starter Motor Noise."

PINION CLEARANCE (Gas Engines)

1. Remove the lower flywheel housing cover.
2. Inspect the flywheel for signs of unusual wear such as chipped or missing gear teeth or the flywheel being bent. If the flywheel needs replacing, refer to SECTION 6.
3. Start the engine and gently touch the outside diameter of the rotating flywheel ring gear with chalk or crayon to show the high point of tooth runout after the engine is turned off. Turn the engine off and rotate the flywheel so the marked teeth are in the area of the starter pinion gear.
4. Disconnect the negative battery cable to prevent accidental cranking of the engine.
5. Measure the clearance between the top of the ring gear tooth and the bottom of the pinion tooth using the width of a wire gage or standard feeler stock (figure 10). Normal clearance is 0.5 to 1.5 mm (0.02 to 0.06 inch).

6D2-8 CRANKING SYSTEM

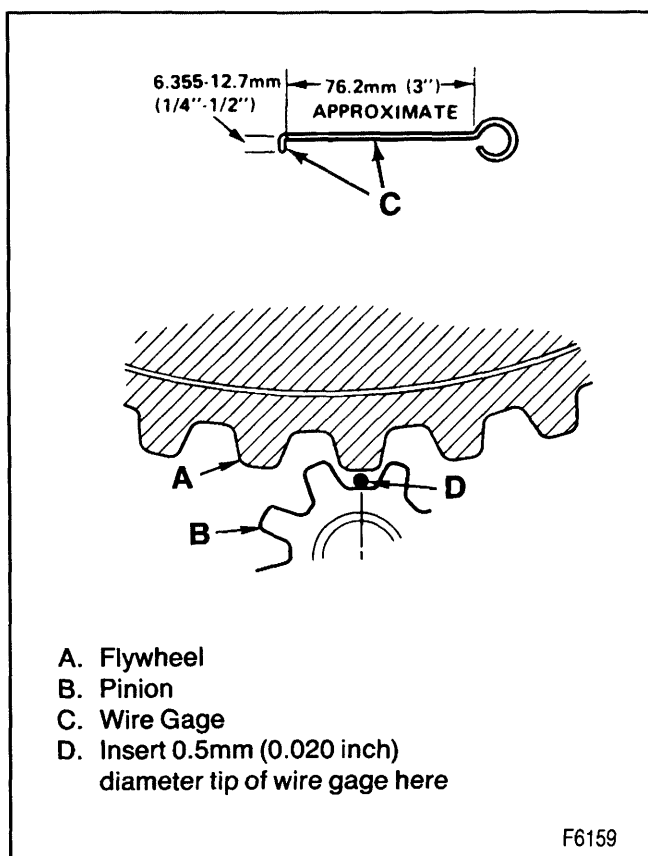


Figure 10—Flywheel to Pinion Clearance

6. If clearance is less than 0.5 mm (0.02 inch), and the starter whines after firing, shim the starter away from the flywheel.

- Add 1.0-mm (0.04-inch) shims, one at a time, to both long bolts between starter mounting pads and the engine until the noise problem is corrected. Do not use more than 2 shims total.

7. If the pinion clearance is more than 1.5 mm (0.06 inch) and the starter whines during cranking, shim the starter toward the flywheel.

- Add 0.33-mm (0.013-inch) shims between the outboard starter mounting pad and the engine mount until the noise stops. Do not add more than 4 shims total.

NOTICE: Refer to "Notice" on page 6D2-1.

8. When shimming is done, tighten the mounting bolts (figure 11).



Tighten

- Mounting bolts to 45 N.m (35 lbs. ft.).

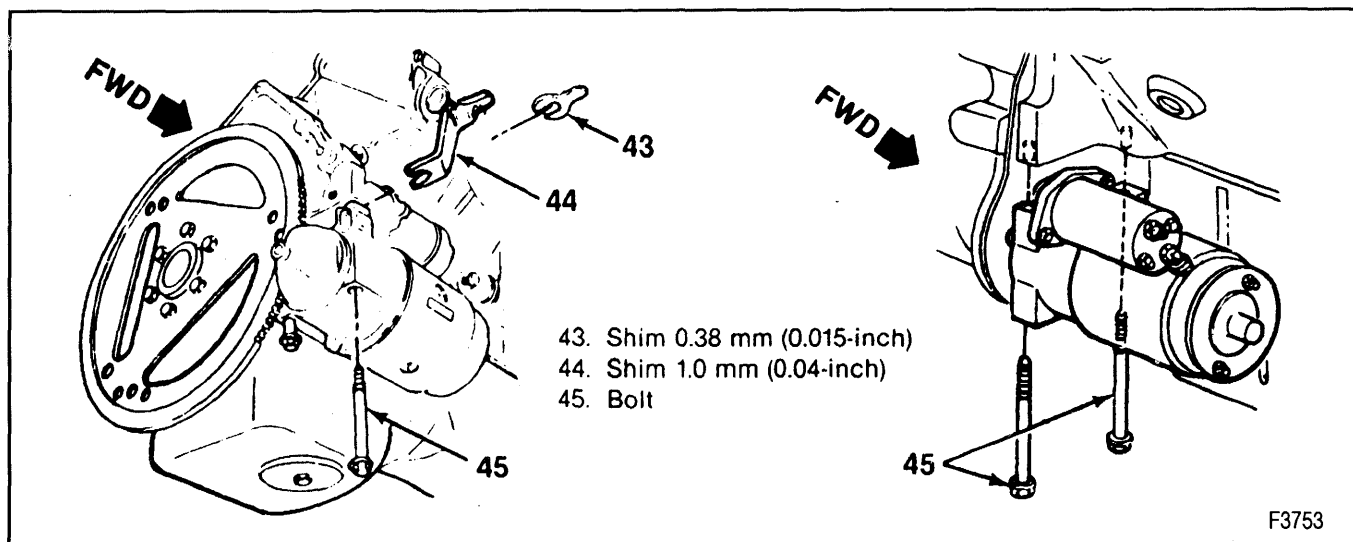


Figure 11—Shimming Gas Engine Starter Motors

ON-VEHICLE SERVICE

Starter motors do not require lubrication except during overhaul.

If the battery, wiring, and switches are in satisfactory condition, and the engine is functioning properly, but cranking problems remain, remove the starter motor. Refer to the Light Duty Truck Unit Repair Manual for repair procedures.

Never operate the starter motor more than 30 seconds at a time without pausing to allow it to cool for at least 2 minutes. Overheating, caused by excessive cranking, will damage the starter motor.

STARTER MOTOR REPLACEMENT

Remove or Disconnect (Figures 12, 13, and 14)

1. Negative battery cable. Refer to CAUTION on page 6D2-1.
2. Starter brackets and/or shields, if equipped.
3. Wires from the starter solenoid.
 - Raise the vehicle and support with safety stands.

4. Two bolts and washers (where present) holding the starter to the engine.
5. Starter from the engine.

Install or Connect (Figures 12, 13, and 14)

NOTICE: Refer to "Notice" on page 6D2-1.

1. Two bolts and washers (where used) through the starter to the engine.

Tighten

- Through bolts to 45 N·m (35 lbs. ft.).
 - Bracket bolt (diesel) to 33 N·m (24 lbs. ft.).
 - Nut (diesel) to 8.5 N·m (75 lbs. in.).
 - Lower the vehicle.
2. Wires to the solenoid terminals.
 3. Brackets and/or shields, if equipped.
 4. Negative battery cable.

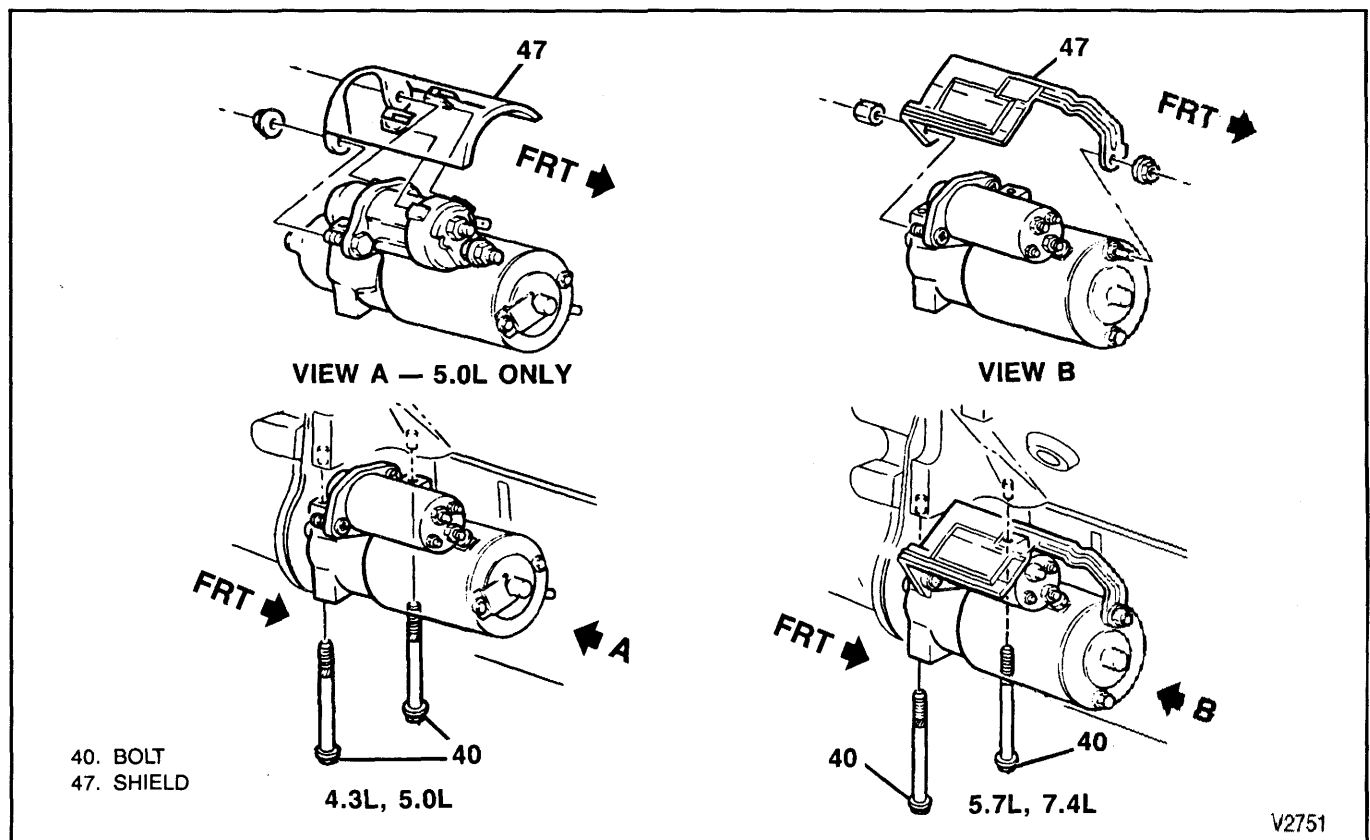


Figure 12—Gas Engine Starter Motors

6D2-10 CRANKING SYSTEM

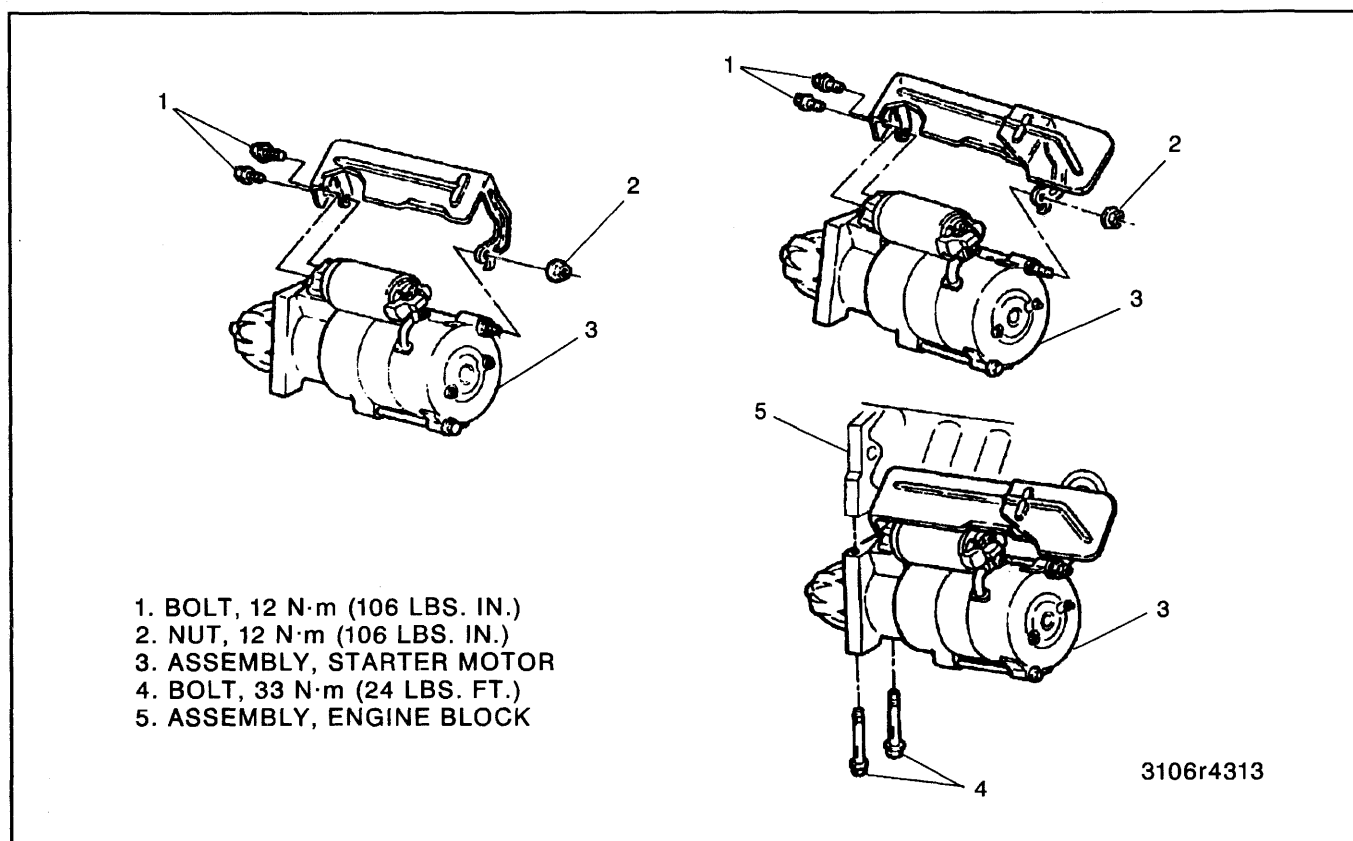


Figure 13—Gas Engine Starter Motors (5.7, 7.4L - Late Production)

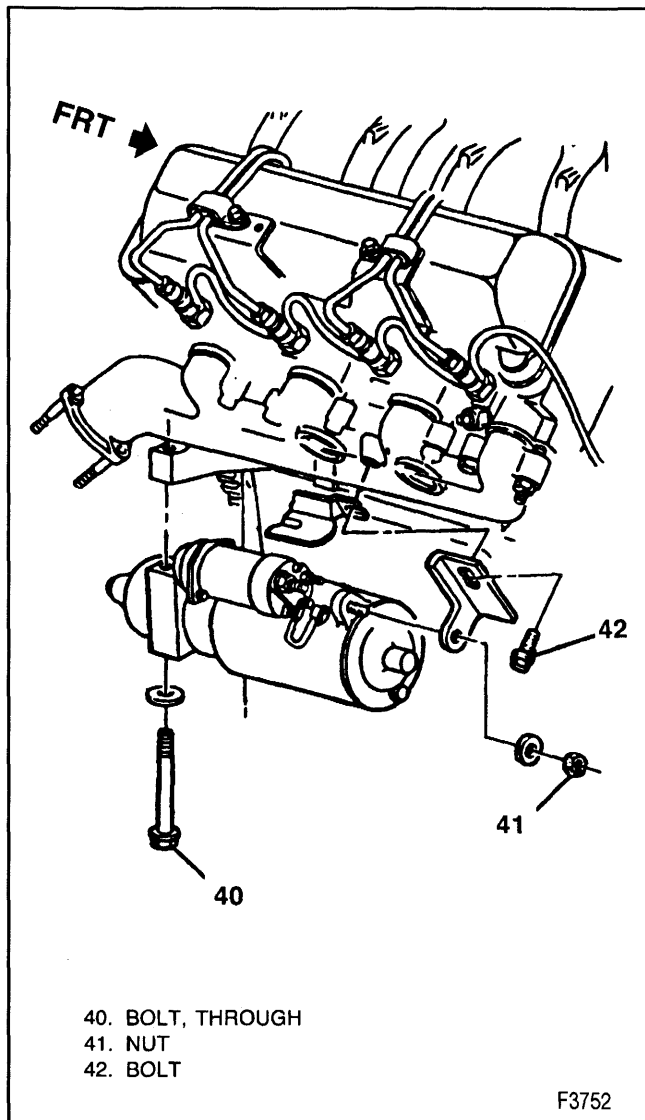


Figure 14—Diesel Engine Starter Motor

6D2-12 CRANKING SYSTEM

SPECIFICATIONS STARTER SPECIFICATIONS

Engine Application				Load Test @ 10 Volts			
				AMPS		RPM	
				Minimum	Maximum	Minimum	Maximum
4.3L		10455013	SD-260	50	62	8500	12700
5.0L		10455013	SD-260	50	62	8500	12700
5.7L, 7.4L	Man. Trans.	10455305	SD-300	70	110	6500	10700
	Auto. Trans.	10455306	SD-300	70	110	6500	10700
5.7L, 7.4L		9000786	PG-260	64	95	2825	3275
Diesel	Auto. Trans.	1113295	28MT	130	190	2300	5600
	Man. Trans.	1113296	28MT	130	190	2300	5600

T2135

STARTER SHIMS Gas Engines

Shim	Part No.
0.33 mm (0.013-inch)	1246249
1.0 mm (0.04-inch)	14036090

T2937

FASTENER TIGHTENING SPECIFICATIONS

	N-m	Ft. Lbs.	In. Lbs.
Starter Motor Mounting Bolts:			
Gas Engines			
4.3L, 5.0L	45	35	—
5.7L, 7.4L	45	35	—
Diesel Engines			
Through Bolts	45	35	—
Nut	8	—	75
Bolt.....	32	24	—

T2137

SECTION 6D3

CHARGING SYSTEM

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Fastener Tightening Specifications	6D3-6
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GENERAL DESCRIPTION

The charging system consists of the battery, the generator, the regulator, and the charging system indicator lamp circuitry. The generator supplies electrical power for charging the battery and operating accessories.

CS-130 GENERATOR

The CS-130 (figure 1) generator features a high ampere output per pound of weight. The CS stands for charging system and 130 is the measurement in millimeters of the outside diameter of the stator laminations.

This generator with integral regulator does not have a diode trio. The delta stator, rectifier bridge, and rotor with slip rings and brushes are electrically similar to other CS-series generators. A conventional fan and pulley are used and an internal fan cools the slip rings, end frame, rectifier bridge, and regulator.

The charge indicator, that appears on the instrument panel as a battery symbol, turns on when the ignition switch is closed and turns off when the engine is running. If the charge indicator is on with the engine running, a charging system problem is indicated. This

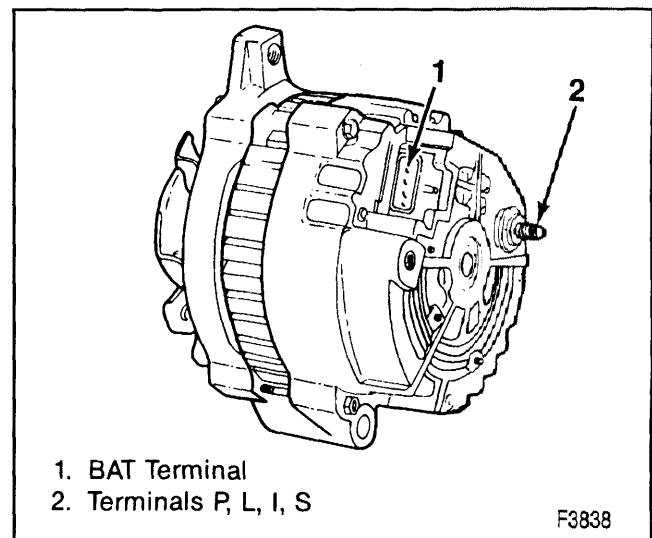


Figure 1—CS-130 Generator

6D3-2 CHARGING SYSTEM

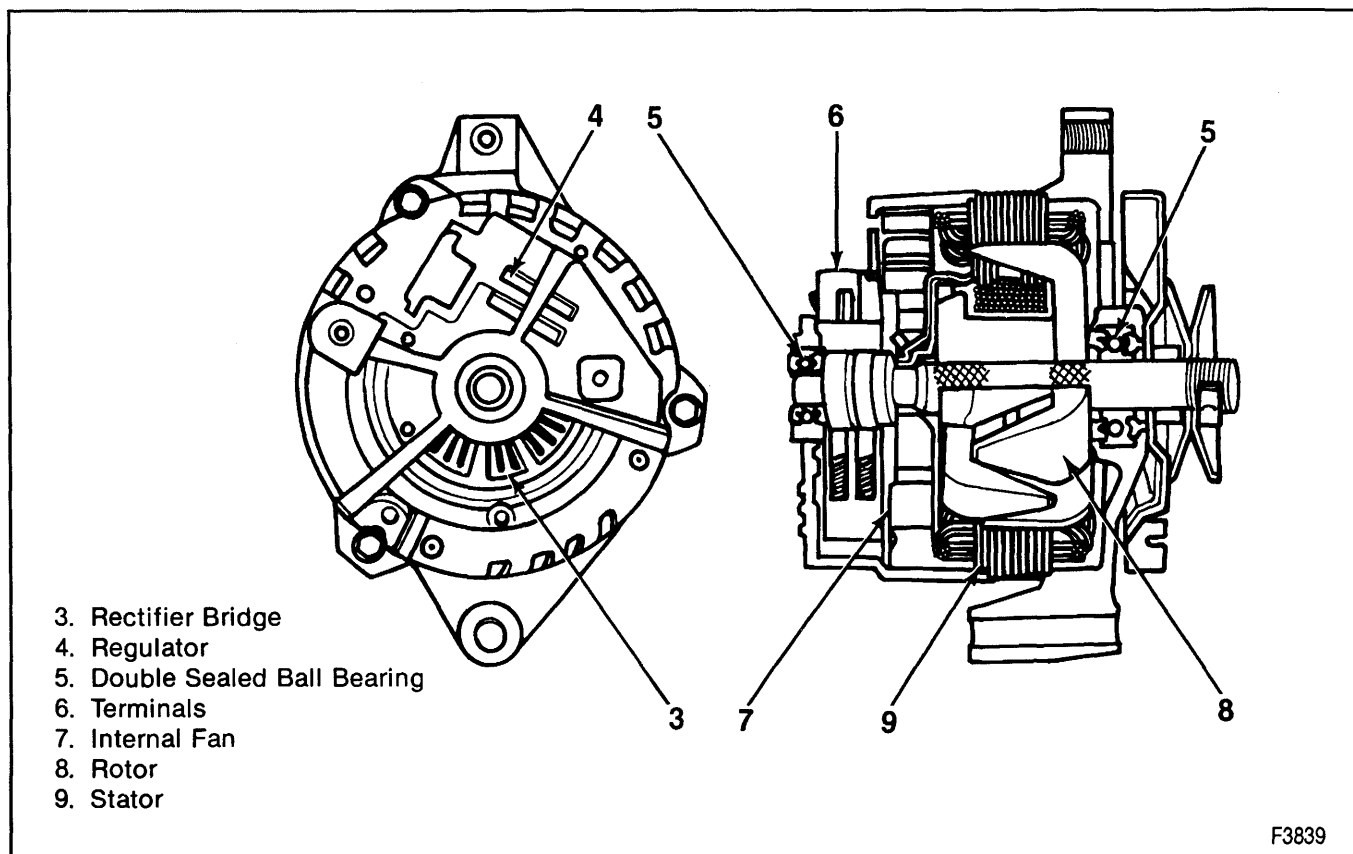


Figure 2—Generator Components

indicator will glow at full brilliance, not half lit, if any charging problem occurs or the system voltage is too high or too low.

The regulator voltage setting varies with temperature and limits system voltage by controlling rotor field current. When the field current is "ON," the regulator actually switches the rotor field current on and off at a fixed rate of about 400 cycles per second. By varying the overall on-off time, correct average field current for proper system voltage control is obtained. At high speeds, the on-time may be 10 percent and the off-time 90 percent. At low speeds, with high electrical loads, on-off time may be 90 percent and 10 percent respectively.

The regulator has four terminals, "P," "L," "I," and "S" (figure 2). The regulator and/or the connector may be stamped "PLI/FS," or "PLFS."

Either the "L" or "I" terminal (or both) turns the regulator on and allow field current to flow when the switch is closed. The "L" terminal must be connected through an indicator lamp or a suitable resistor. The "I" terminal may be connected either directly to battery positive or through a resistor. These two terminals are often used in parallel, connected to two different vehicle circuits. The "P" terminal is connected internally to the stator and may be wired to a tachometer or other device. The "S" terminal may be used to sense voltage at another location on the vehicle for voltage control. If the "S" terminal is not used, the generator uses an internal voltage sense for control. Refer to the electrical diagnosis section of NATP-9442.

The generator is not serviceable and no periodic maintenance is required. It should not be disassembled for any reason.

DIAGNOSIS

NOISY GENERATOR

Noise from a generator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, worn stator, or worn rectifier bridge. If the pulley and mounting bolts are snug and the noise continues, replace the generator. Refer to "Generator Replacement."

Do not disassemble the generator. Separating the end frames will damage the slip ring end bearing. This generator is serviceable by complete replacement only.

ELECTRICAL TESTS

Before performing the diagnosis procedures on the vehicle, make sure the system wiring is good and the generator belt is not slipping. Also, the battery must be fully charged for a valid test of the charging system.

NOTICE: To avoid damage to the vehicle electrical system, observe the following precautions:

- Do not polarize the generator.
- Do not short across or ground any of the terminals in the charging circuit except as specifically instructed herein.
- NEVER disconnect the output terminal while the generator is operating.
- Make sure the generator and battery have the same ground polarity.
- When connecting a charger or booster battery to the vehicle battery, connect negative to negative and positive to positive.

CIRCUIT DIAGNOSIS

Trouble in the charging system will show up as one or more of the following conditions:

- Abnormal indicator lamp operation.
- A high or low voltage indication with the engine running and all accessories off.
- An undercharged battery as evidenced by slow cranking or a dark hydrometer.
- An overcharged battery as evidenced by excessive spewing of electrolyte from the vents.

A basic wiring diagram for the charging system is shown in figure 3. When the system is operating normally, the indicator lamp will turn on when the ignition switch is turned on and turn off when the engine starts. If the lamp operates abnormally or an undercharged or overcharged battery condition occurs, the following procedure may be used to diagnose the charging system. Remember that an undercharged battery is often caused by accessories being left on overnight or by a switch stuck closed that allows a lamp, such as an instrument panel compartment lamp, to stay on.

This generator does not have a test hole.

DIAGNOSTIC TEST FOR CS-130

Tool Required:

J 39200 Digital Multimeter

1. Check the belt for wear and tension. Refer to SECTION 6B1 for belt diagnosis. Check the wiring.

2. With the ignition switch on and the engine off, the lamp should be on. If not, detach the wiring harness at the generator and use a fused jumper wire (J 36169 or equivalent with a 5-amp fuse) to ground the "L" terminal lead in the wiring harness (figure 3).

- If the lamp lights, replace the generator.
- If the lamp does not light, locate the open circuit between the grounding lead and the ignition switch. The lamp may be open.

3. With the ignition switch on and the engine running at moderate speed, the lamp should be off. If not, stop the engine, turn the ignition switch on, and disconnect the wiring harness at the generator.

- If the lamp goes out, replace the generator.
- If the lamp stays on, check for a grounded "L" terminal wire in the harness.

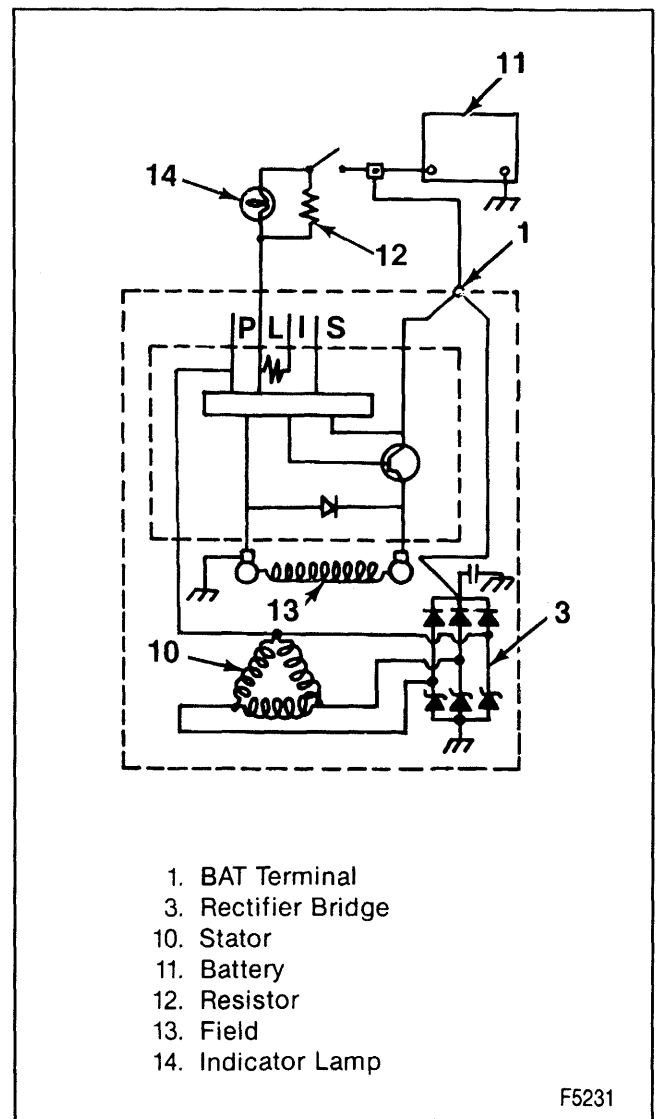


Figure 3—CS-130 Generator Schematic

6D3-4 CHARGING SYSTEM

4. If the battery is undercharged or overcharged or the vehicle voltmeter shows high or low voltage with the engine running:
 - A. Disconnect the wiring harness connector from the generator.
 - B. With the ignition switch on and the engine not running, connect J 39200 from ground to the "L" terminal in the wiring harness. A zero reading indicates an open or grounded circuit between the terminal and the battery. Correct as required.
 - C. Connect the harness connector to the generator and run the engine at moderate speed with accessories off.
 - D. Measure the voltage across the battery. If it is above 16 volts, replace the generator.
 - E. With the engine off, connect an ammeter at the generator output terminal. The ammeter must have the capability to measure 115 amps of current. Connect J 39200 across the generator and a carbon pile across the battery.
 - Run the engine at moderate speed, turn on the accessories, and load the battery with a carbon pile to obtain maximum amperage. Maintain voltage at 13 volts or above.
 - If the output in amperes is within 15 amperes of the rated output, the generator is OK. Refer to "Specifications."
 - If the output is not within 15 amperes of the rated output, replace the generator.

GENERATOR BENCH TEST

This test requires both a fully charged battery and a generator test stand to operate the generator.

1. Make connections as shown in figure 4, except leave the carbon pile turned off. The ground polarity of the generator and battery must be the same. The battery must be fully charged. Use a 30 to 500 ohm resistor between the battery and the "L" terminal.
2. Slowly increase the generator speed and observe the voltage.

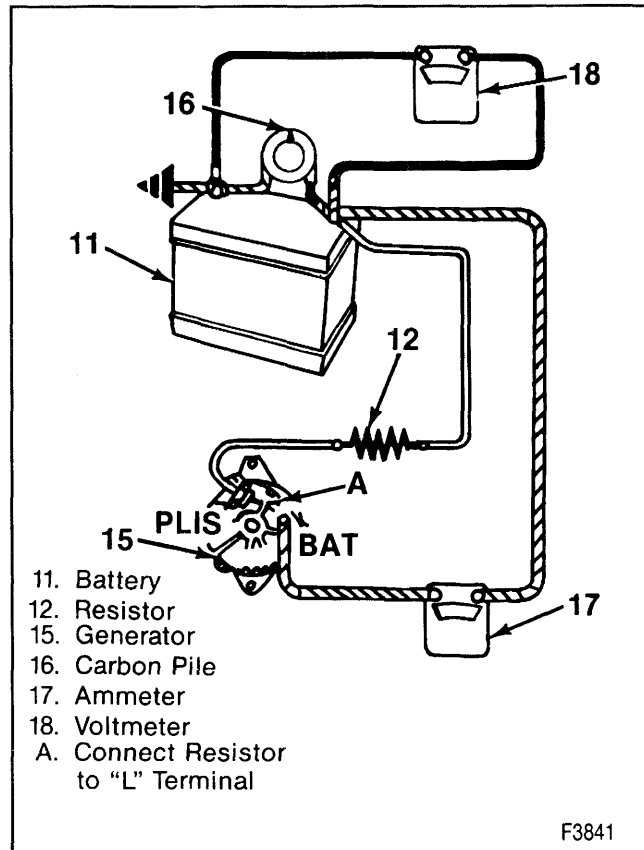


Figure 4—Connections for Generator Output Test

3. If the voltage is uncontrolled and increases above 16 volts, the rotor field is shorted, the regulator is not working properly, or both. A shorted rotor field coil can cause repeat regulator failure.
4. If the voltage is below 16 volts, increase speed and turn on and adjust the carbon pile to obtain maximum amperage output. Maintain the voltage above 13 volts.
5. If the output is within 15 amperes of the rated output, the generator is good.
6. If the output is not within 15 amperes of the rated output, replace the generator.

ON-VEHICLE SERVICE

GENERATOR REPLACEMENT

The removal and installation instructions serve only as a guide. Additional operations may be required on some vehicles to remove other equipment to gain access to the generator, drive belts, and brackets.

CAUTION: Failure to observe step 1 in this procedure may result in an injury from the hot battery lead at the generator.

➡ Remove or Disconnect (Figures 5 through 7)

1. Negative battery cable. Refer to CAUTION on page 6D3-1.

2. Terminal plug and battery lead from the back of the generator.
3. Drive belt. Refer to SECTION 6A.
4. Two mounting bolts.
5. Generator from the mounting bracket.

➡ Install or Connect (Figures 5 through 7)

NOTICE: For steps 1, 2, and 4, refer to "Notice" on page 6D3-1.

Gasoline Engines:

1. Loosely install generator to the bracket with two bolts.



Tighten

- A. Right mounting bolt to 25 N·m (18 lbs. ft.).
- B. Left mounting bolt to 50 N·m (37 lbs. ft.).
- C. Bolt through the bracket and back of the generator to 25 N·m (18 lbs. ft.).

Diesel Engines:

2. Generator to the mounting bracket with bolts.



Tighten

- A. Top mounting bolt to 25 N·m (18 lbs. ft.).
- B. Bottom mounting nut to 23 N·m (17 lbs. ft.).
- C. Bolt at the back of the generator to 25 N·m (18 lbs. ft.).

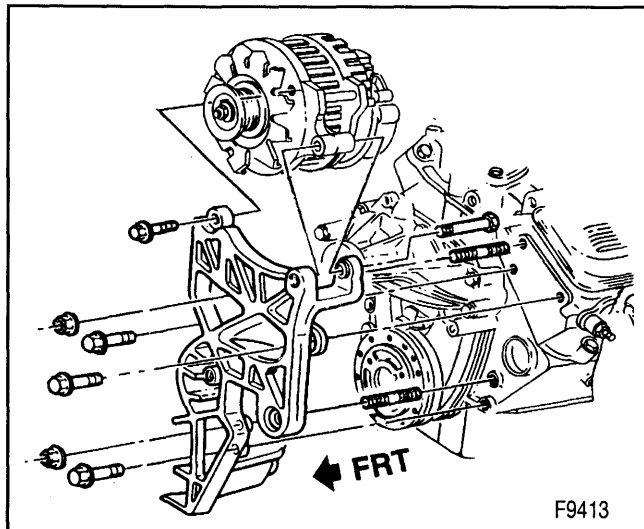


Figure 5—Generator Mounting (4.3L, 5.0L, and 5.7L Engines)

3. Drive belt. Refer to SECTION 6A.
4. Terminal plug and battery lead to the back of the generator.



Tighten

- Battery terminal nut to 8 N·m (71 lbs. in.).
5. Negative battery cable.

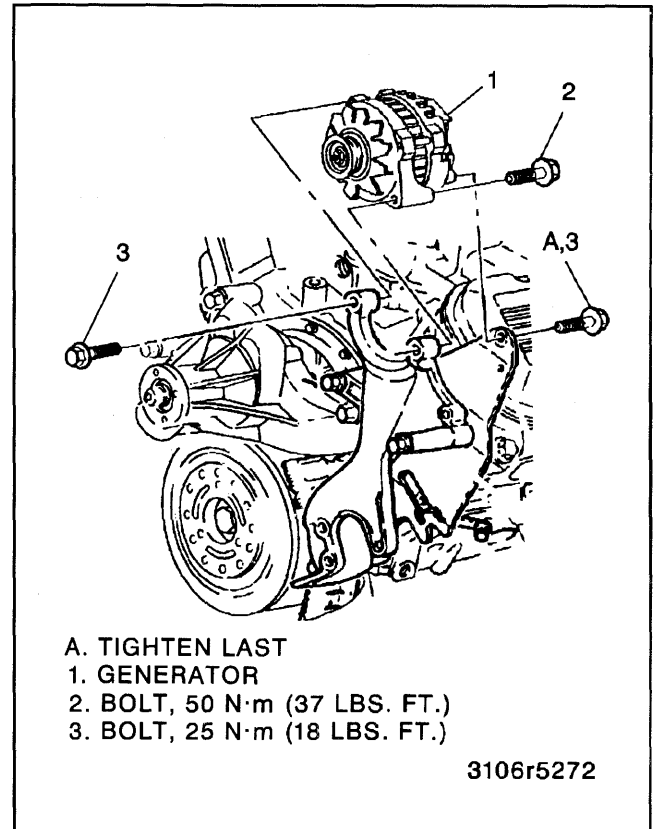


Figure 6—Generator Mounting (7.4L Engine)

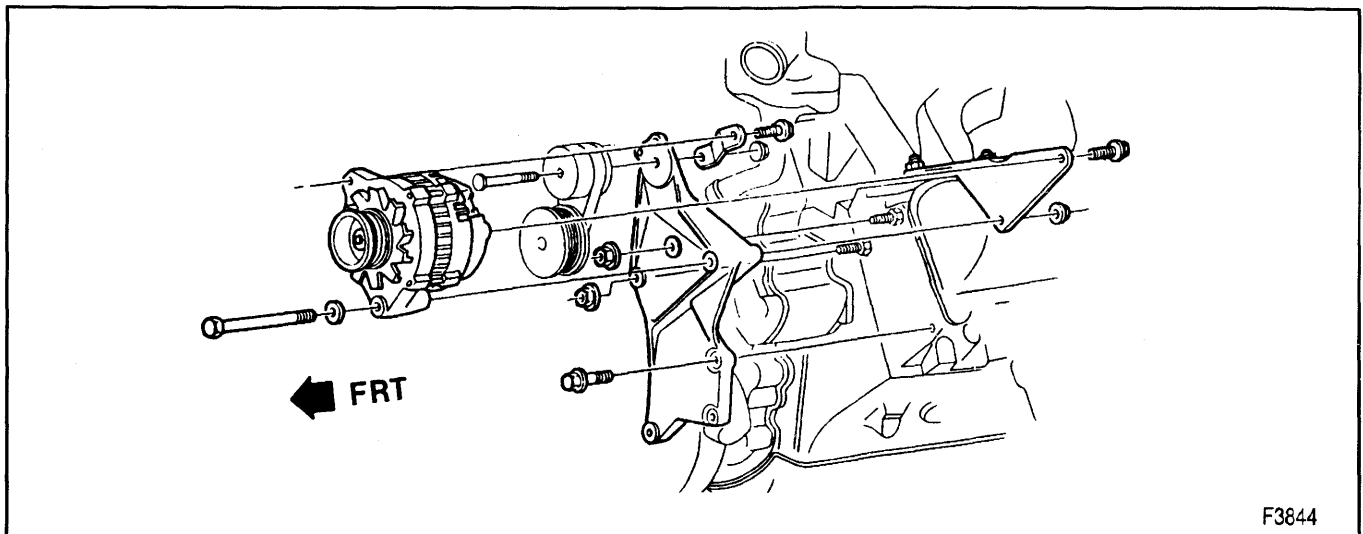


Figure 7—Generator Mounting (Diesel Engines)

6D3-6 CHARGING SYSTEM

SPECIFICATIONS

GENERATOR SPECIFICATIONS

Part No.	Series (Type 100)	Rotation Viewing Drive End	Cold Output AMPS
10480094	CS130	CW	100
10480084	CS130	CW	105
10480086	CS130	CW	100
10480099	CS130	CW	105

T3094

FASTENER TIGHTENING SPECIFICATIONS

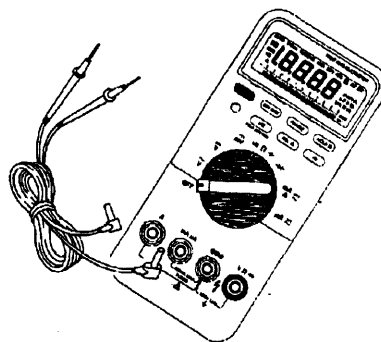
Engine	Generator	Part Number	Top Bracket Bolt		Bottom Bracket Bolt	
			N·m	Lbs. Ft.	N·m	Lbs. Ft.
4.3L	K60	10480094	25	18	50	37
With Dual A/C	K68	10480084	25	18	50	37
5.0L	K60	10480094	25	18	50	37
With Dual A/C	K68	10480084	25	18	50	37
5.7L	K60	10480094	25	18	50	37
With Dual A/C	K68	10480084	25	18	50	37
7.4L	K60	10480094	50	37	25	18
With Dual A/C	K68	10480084	50	37	25	18
6.5L	K60	10480086	25	18	23*	17*
With Dual A/C	K68	10480099	25	18	23*	17*

* Nut Torque

T3095

SPECIAL TOOLS

1.



J 39200

1. J 39200 DIGITAL MULTMETER

2906r5350

SECTION 6D4

IGNITION SYSTEM

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

IGNITION SYSTEM

Ignition systems used on these vehicles include a battery, distributor, ignition coil, ignition switch (gasoline engines), spark plugs, and primary and secondary wiring. Information on the battery is located in SECTION 6D1. Refer to SECTIONS 3F1 and 3F2 for information on the ignition switch.

DISTRIBUTOR IGNITION (DI) SYSTEM

The distributor ignition (DI) system is part of the computerized engine control system. The computers in these vehicles are PCMs (powertrain control module). The computer monitors information from various engine sensors, computes the desired spark timing, and sig-

6D4-2 IGNITION SYSTEM

nals the ignition control module to change engine timing.

The distributor does not contain centrifugal advance weights, springs, or a vacuum advance unit.

The distributor has a separate ignition coil that connects to the rotor through a high tension wire (figure 1).

The distributor has an internal magnetic pickup assembly that contains a permanent magnet, a pole piece with internal teeth, and a pickup coil. When the rotating teeth of the timer core line up with the teeth of the pole piece, voltage is induced in the pickup coil. This voltage signals the ignition control module (ICM) to trigger the primary ignition circuit. Current flow in the primary circuit is interrupted and a high voltage of up to 35,000 volts is induced in the ignition coil secondary winding. This high voltage is directed through the secondary ignition circuit to fire the spark plugs.

The distributor is driven by the camshaft and mounts to the rear of the engine.

No periodic lubrication is required. Engine oil lubricates the lower bushing. The upper bushing is prelubricated and sealed.

For information on the distributor ignition system, system components and their locations, and diagnostic charts, refer to the driveability and emissions section of NATP-9442.

UNIT REPAIR INFORMATION

For bench repair of the distributor, refer to SECTION 6D4A of the Light Duty Truck Unit Repair Manual.

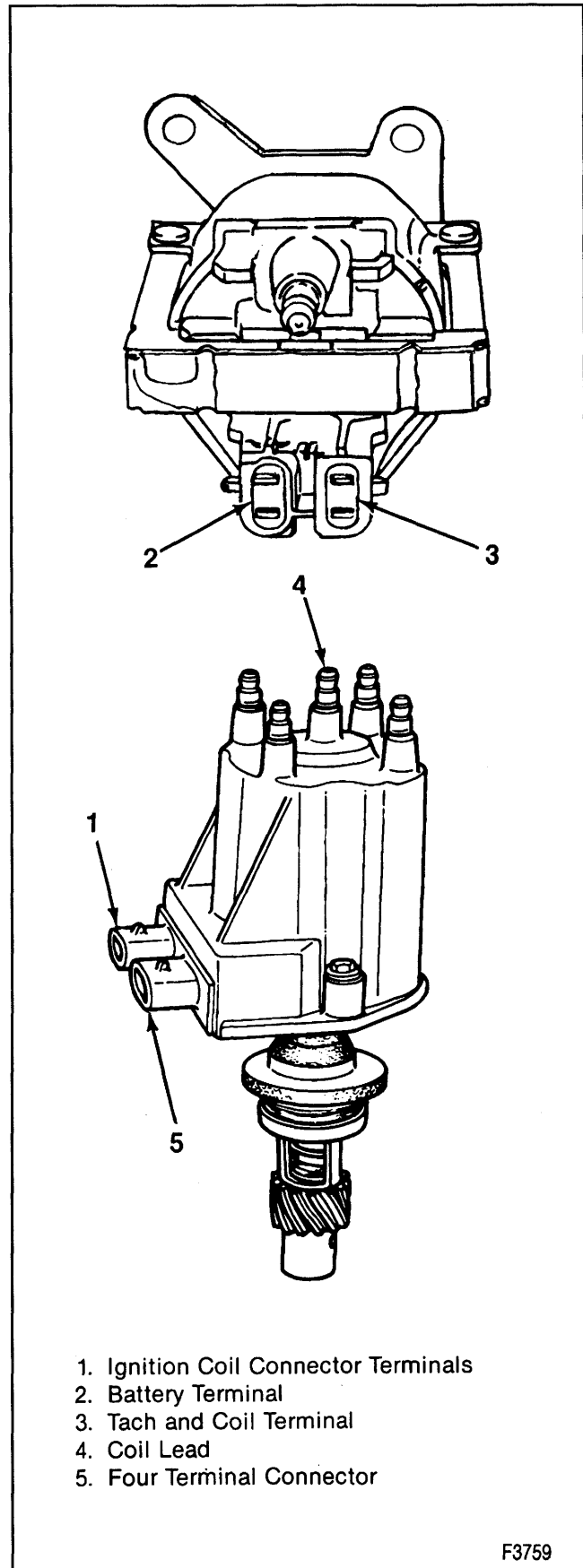
IGNITION BASE TIMING

Base timing specifications are listed on the Vehicle Emissions Control Information label located on the air cleaner (vehicles above 8500 GVWR) or on the fan shroud. Always follow the Vehicle Emissions Control Information label procedures when adjusting ignition base timing. When using a timing light, connect an adapter between the No. 1 spark plug and the No. 1 spark plug wire, or use an inductive type pickup. DO NOT pierce the spark plug wire or boot. Once the insulation has been broken, voltage will jump to the nearest ground, and the spark plug will not fire properly.

Some engines incorporate a magnetic timing probe hole for use with special electronic timing equipment. Consult the manufacturer's instructions for use of this equipment.

SPARK PLUGS

Resistor-type, tapered-seat spark plugs are used on all gasoline engines. No gasket is used on these spark plugs. Figures 2 and 3 explain the letter coding on these spark plugs. A dot before the spark plug code or the letter "C" after the number in the code indicates the spark plug has a copper core. Refer to SECTION 0B or the Vehicle Emissions Control Information label in the engine compartment for correct spark plug gap information.



F3759

Figure 1—Distributor with Sealed Module Connector and Separate Coil

These spark plugs have a ceramic insulator that is approximately 6.35 mm (1/8 inch) longer than conventional spark plugs (figure 4). The longer length spark plugs magnify the problem of cracked insulators because most spark plug sockets are not of sufficient length to properly engage the shell hex. If the spark plug shell hex is not fully engaged in the spark plug socket wrench, the socket may cock at an angle and cause insulator cracking and/or breakage during spark plug installation or removal.

When servicing these spark plugs, make sure the spark plug socket being used is deep enough to accommodate the longer length insulator (figure 5). Using a spark plug socket that is NOT deep enough may result in the ceramic insulator becoming cracked above the spark plug shell.

Normal or average service is defined as a mixture of idling, low speed, and high speed operation with some of each making up the daily total driving. Occasional or intermittent high-speed driving is essential to good spark plug performance. It provides increased and sustained combustion heat that burns away any excess deposits of carbon or oxide that may have accumulated from frequent idling or continual stop-and-go or slow-speed driving. Spark plugs are protected by an insulating boot made of a special heat-resistant material that covers the spark plug terminal and extends downward over a portion of the plug insulator. These boots prevent flash-over with resultant missing of the engine.

Do not mistake corona discharge for flash-over or a shorted insulator. Corona is a steady blue light appearing around the insulator, just above the shell crimp. It is the visible evidence of a high-tension field, and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between the shell and insulator.

SPARK PLUG WIRES

Spark plug wires have an outer layer of silicone. The silicone spark plug boots form a tight seal on the spark plugs and the distributor cap tower. Refer to "Spark Plug Wiring and Boots" for service precautions.

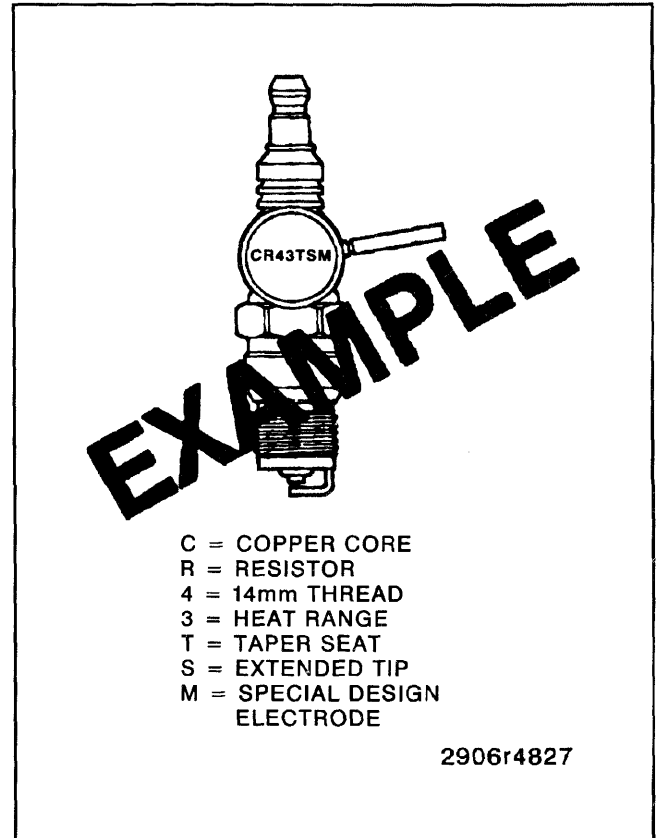


Figure 2—Spark Plug Coding

Numbers relate to thread size as follows:
1st number denotes THREAD SIZE

4 = 14mm	2 = 1/2 - INCH TAPER
8 = 18mm	5 = 1/2 - INCH
10 = 10mm	6 = 3/4 - INCH
12 = 12mm	7 = 7/8 - INCH

2nd number denotes HEAT RANGE

0 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9

COLD - - - - HOT

2906r4828

Figure 3—Spark Plug Coding Legend

6D4-4 IGNITION SYSTEM

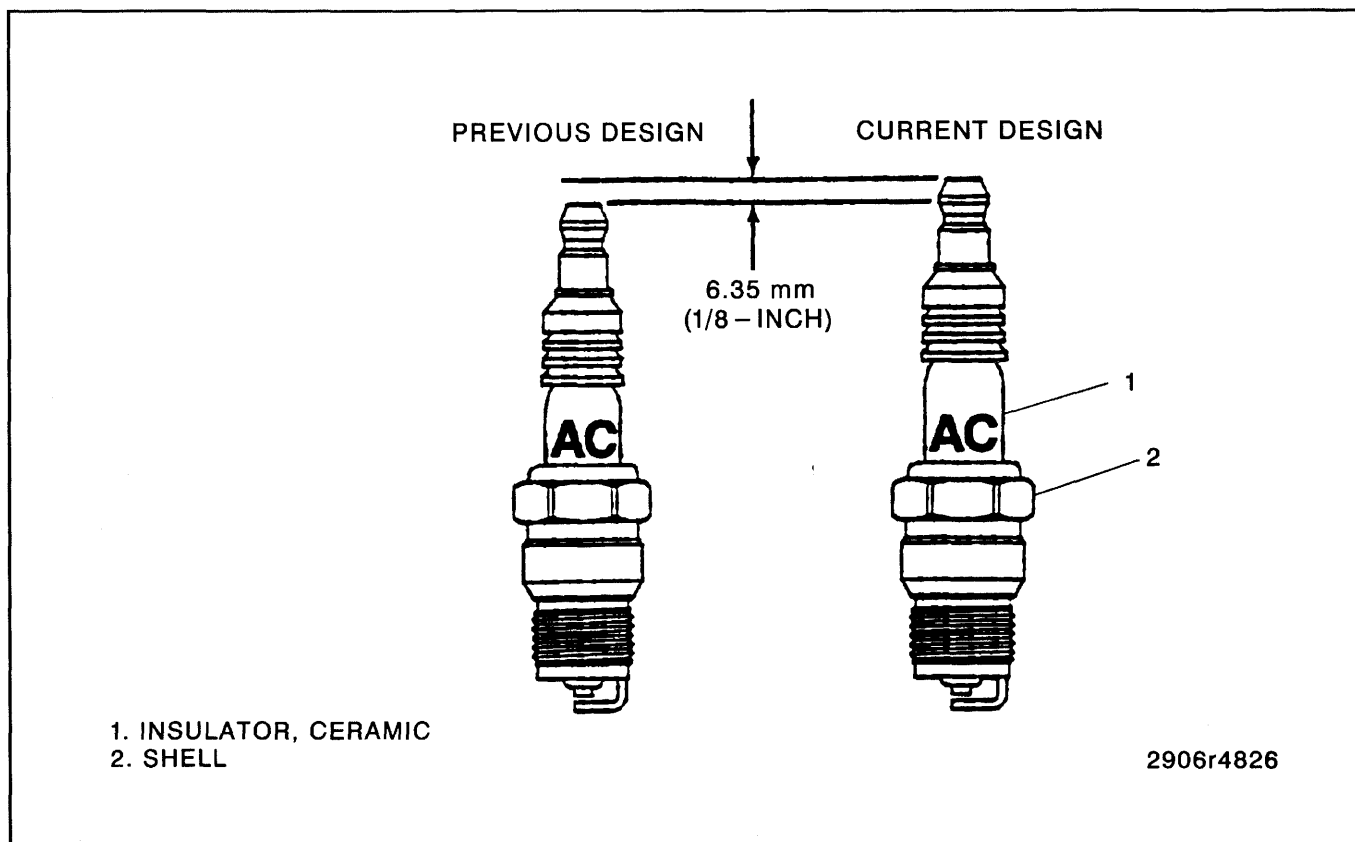


Figure 4—Extended Length Ceramic Insulators

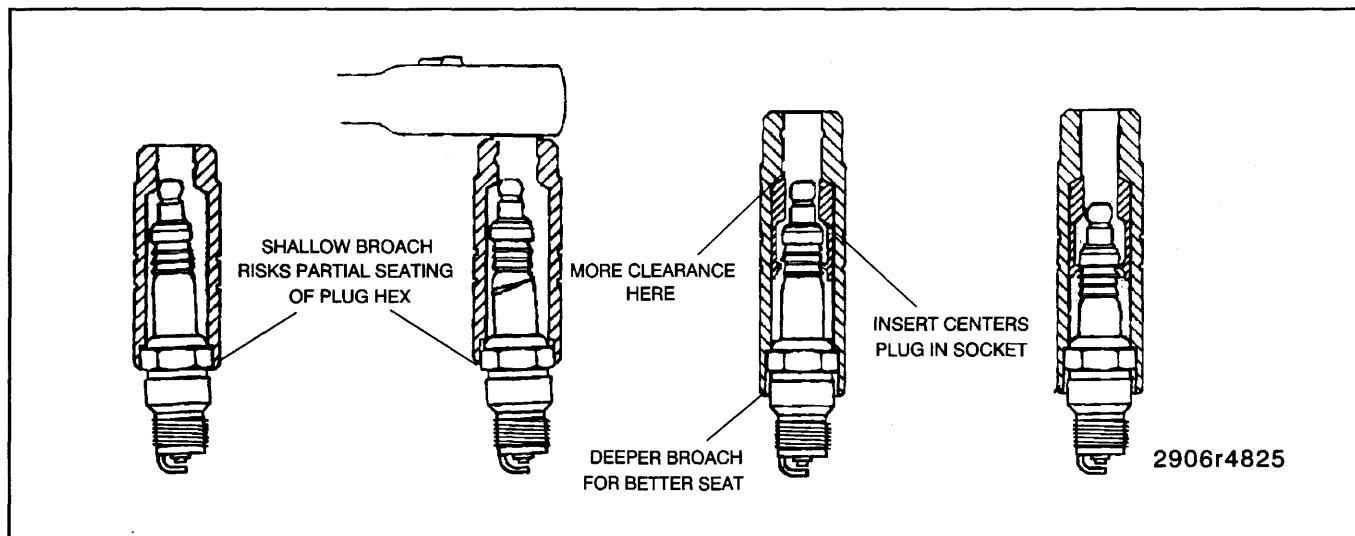


Figure 5—Spark Plug Socket Precautions

DIAGNOSIS

DISTRIBUTOR IGNITION SYSTEM

The driveability and emissions section of NATP-9442 covers this system, including the diagnostic use of the malfunction indicator ("Service Engine Soon") lamp.

DISTRIBUTOR INSPECTION



Inspect

1. Distributor cap for cracks or tiny holes. Replace it if it is damaged or worn.

2. Metal terminals in the distributor cap for corrosion. Scrape them clean with a knife or replace the distributor cap.
3. Rotor for wear or burning at the outer terminal. The presence of carbon on the terminal indicates rotor wear and the need for replacement.
4. Distributor shaft for shaft-to-bushing looseness. Insert the shaft in the distributor housing. If the shaft wobbles, replace the housing and/or shaft.
5. Distributor housing for cracks or damage.



Measure

Tools Required:

J 24642-F Module Tester

- Electrical performance of the module. The module can only be checked with an approved module tester, such as J 24642-F. Follow the directions that come with the tester.

IGNITION COIL TEST

Tool Required:

J 39200 Digital Multimeter

- Make sure the ignition switch is "OFF."
1. Disconnect the distributor lead and wiring from the ignition coil.
 2. Connect J 39200 as shown in step 1 of figure 6. Use the high scale. The reading should be OL (infinite). If not, replace the ignition coil.
 3. Connect J 39200 as shown in step 2 of figure 6. Use the low scale. The reading should be very low or zero. If not, replace the ignition coil.

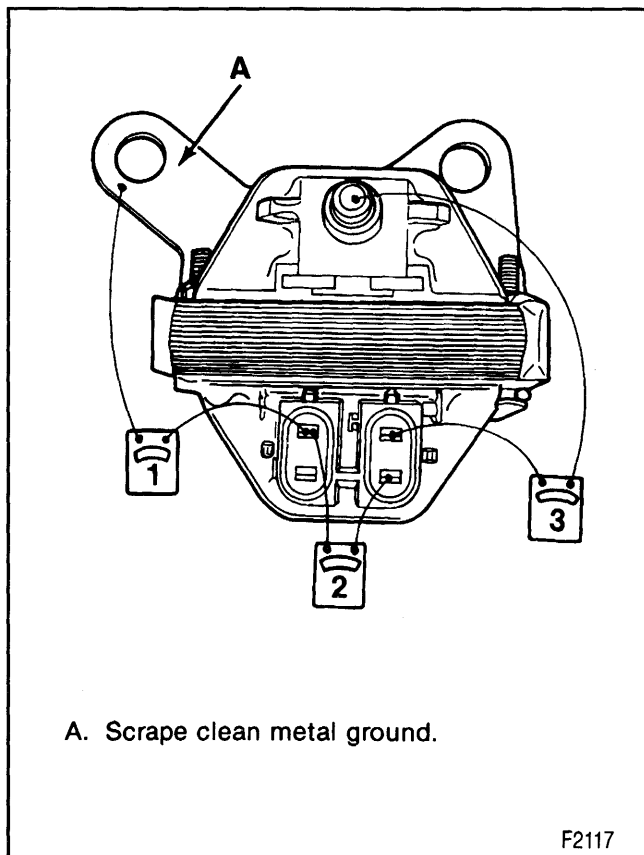


Figure 6—Testing the Ignition Coil

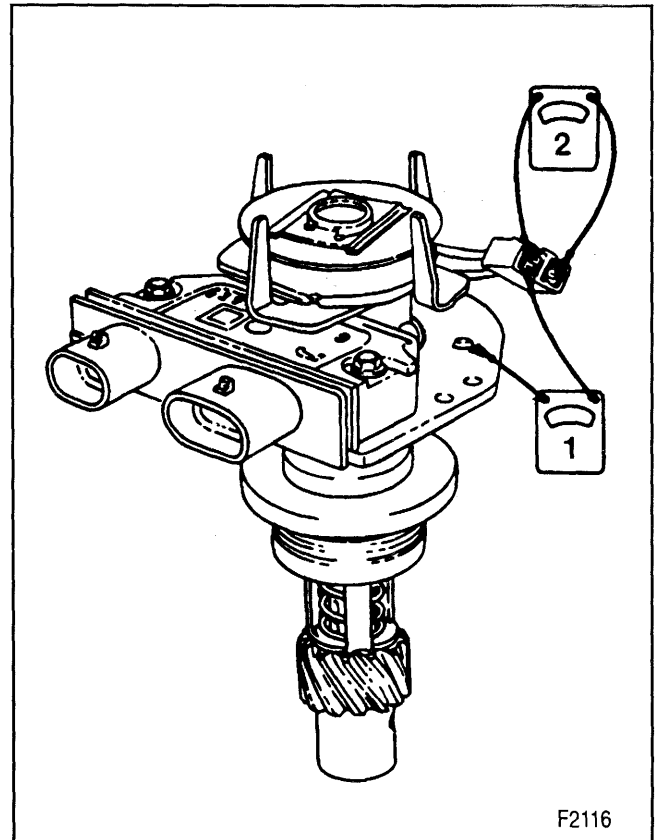


Figure 7—Testing the Pickup Coil

4. Connect J 39200 as shown in step 3 of figure 6. Use the high scale. The meter should not read OL (infinite). If it does, replace the ignition coil.
5. Reconnect the distributor lead and wiring to the ignition coil.

PICKUP COIL TEST

Tool Required:

J 39200 Digital Multimeter

- Make sure the ignition switch is "OFF."

1. Remove the distributor cap.
2. Disconnect the pickup coil connector from the ignition control module.
3. Check the resistance of the pickup coil with J 39200 .

- A. Connect J 39200 to either pickup coil lead and the housing as shown in step 1 of figure 7. The reading should be OL (infinite). If not, replace the pickup coil.
- B. Connect J 39200 to both pickup coil leads as shown in step 2 of figure 7. Flex the leads by hand at the pickup coil and the connector to locate any intermittent opens. J 39200 should read a constant value from 500 to 1500 ohms. If not, replace the pickup coil.

- To replace the pickup coil, remove the distributor. Refer to "Distributor and Coil Replacement." Refer to SECTION 6D4A in the Light Duty Truck Unit Repair Manual for distributor disassembly.

6D4-6 IGNITION SYSTEM

VISUAL INSPECTION OF SPARK PLUG WIRES AND BOOTS

1. Check the routing of the wires. Improper routing can cause crossfiring.
2. Remove and check each wire for any signs of cracks or splits in the wire.
3. Inspect each boot for signs of tears, piercing, arc through, or carbon tracking. If the boot needs to be replaced, twist it a half turn in either direction to break the seal before pulling on the boot to remove the wire.

SPARK PLUG WIRE RESISTANCE TEST

1. Disconnect both ends of each spark plug wire. Make sure the spark plug wire terminals are clean.

2. Set J 39200 on the high scale and connect it to each end of the spark plug wire being tested. Twist the spark plug wire gently while watching J 39200 .
3. If J 39200 reads above 30,000 ohms (no matter how long the spark plug wire is), or fluctuates from infinity to any value, replace the spark plug wire.
4. If the resistance of any spark plug wire is not within the following ranges, replace the spark plug wire being tested.
 - 0 to 15-inch wire - 3,000 to 10,000 ohms.
 - 15 to 25-inch wire - 4,000 to 15,000 ohms.
 - 25 to 35-inch wire - 6,000 to 20,000 ohms.
 - Longer wires should measure about 5,000 to 10,000 ohms per foot.

DIAGNOSIS OF SPARK PLUGS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Brown to grayish-tan deposits and slight electrode wear.	Normal wear.	Clean, regap, reinstall.
Dry, fluffy black carbon deposits.	Poor ignition output.	Check distributor to coil connections. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model.
Wet, oily deposits with very little electrode wear.	1. "Break-in" of new or recently overhauled engine. 2. Excessive valve stem guide clearances. 3. Worn intake valve seals.	1. Degrease, clean and reinstall the plugs. 2. Refer to Section 6A. 3. Replace the seals.
Red, brown, yellow and white colored coatings on insulator. Engine misses intermittently under severe operating conditions.	By-products of combustion.	Clean, regap, and reinstall. If heavily coated, replace.
Colored coatings heavily deposited on the portion of the plug projecting into the chamber and on the side facing the intake valve.	Leaking seals if condition is found in only one or two cylinders.	Check the seals. Replace if necessary. Clean, regap, and reinstall the plugs.
Shiny yellow glaze coating on insulator.	Melted by-products of combustion.	Avoid sudden acceleration with wide-open throttle after long periods of low speed driving. Replace the plugs.
Burned or blistered insulator tips and badly eroded electrodes.	Overheating.	1. Check the cooling system. 2. Lean air-fuel mixture. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual for this model. 3. Check the heat range of the plugs. May be too hot. 4. Check ignition timing. May be over-advanced. 5. Check the torque value of the plugs to ensure good plug-engine seat contact.

DIAGNOSIS OF SPARK PLUGS (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Broken or cracked insulator tips.	Heat shock from sudden rise in tip temperature under severe operating conditions. Improper gapping of plugs.	Replace the plugs. Gap correctly.
D0071		

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

Some service tachometers and electronic diagnostic equipment may NOT be compatible with this ignition system. Consult your representative on such equipment.

- When making compression checks, disconnect the ignition switch feed wire at the distributor.
 - When disconnecting this connector, release the locking tab while pulling downward on the connector body. Do not use a screwdriver or tool to release the locking tab. It may break the tab.
- No periodic lubrication of the distributor is required. Engine oil lubricates the lower bushing and the upper bushing is permanently sealed and lubricated.
- The tachometer (TACH) terminal is next to the ignition switch (BAT) connector on the distributor cap.

NOTICE: The tachometer terminal must NEVER be allowed to touch ground, because damage to the ignition control module inside the distributor and/or ignition coil can result.

- There is no manual dwell adjustment.
- The material used to construct the spark plug wires is very pliable and soft. Spark plug wire will withstand more heat and carry a higher voltage. Due to the pliable spark plug wire, scuffing and cutting becomes easier. It is therefore extremely important to route spark plug wires correctly to prevent chafing or cutting. When removing a spark plug wire from a spark plug, twist the boot on the spark plug and pull on the boot to remove the wire.

DISTRIBUTOR AND COIL REPLACEMENT

DISTRIBUTOR

Replacement distributors are not available preassembled. All the component parts are available to assemble a new distributor.

Some components, such as the air cleaner, may need to be removed to reach the distributor.

The distributor has a separate ignition coil that is bracket-mounted on top of the engine.

Remove or Disconnect (Figures 8, 9, and 10)

- Make sure the ignition switch is "OFF."

- Air cleaner and hoses.
- Wiring harness connectors at the side of the distributor cap.
- Two screws on the sides of the distributor cap.
- Ignition coil wire and spark plug wires on either the left or right side of the distributor.
- Distributor cap and move it aside.
 - Use chalk to note the position of the rotor in relation to the engine.
 - Use chalk to note the position of the distributor housing in relation to the engine.
- Distributor bolt and hold-down clamp.
- Distributor and gasket.



Install or Connect (Figures 8, 9, and 10)

- To ensure correct ignition base timing of the distributor, it must be installed with the rotor correctly positioned as noted in step 5 of the removal procedure. Line up the rotor and the mark on the engine.
- If the distributor shaft won't drop into the engine, insert a screwdriver into the hole for the distributor and turn the oil pump driveshaft to align it with the distributor.

- Distributor and gasket.

NOTICE: Refer to "Notice" on page 6D4-1.

- Hold-down clamp and bolt.



Tighten

- Bolt to 34 N·m (25 lbs. ft.).

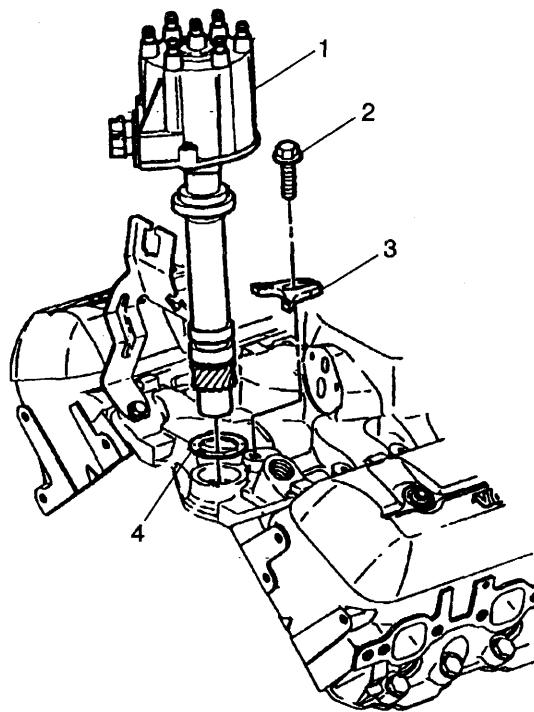
- Distributor cap.
 - Wiring harness connectors at the side of the distributor.
 - Spark plug wires and ignition coil wire.
 - Air cleaner and hoses.
- Check the ignition base timing.

IGNITION COIL



Remove or Disconnect

- Make sure the ignition switch is "OFF."
- Electrical connectors at the side of the ignition coil.
 - Ignition coil wire.
 - Nuts holding the ignition coil bracket and ignition coil to the engine.



1. DISTRIBUTOR
2. BOLT 27 N m (20 LBS. FT.)
3. CLAMP
4. GASKET
5. WIRE, COIL
6. COIL, IGNITION

2906r4739

Figure 8—Distributor and Ignition Coil (4.3L Engine)

4. Ignition coil bracket and ignition coil.

- Drill and punch out the two rivets holding the ignition coil to the bracket.

5. Ignition coil from the bracket.



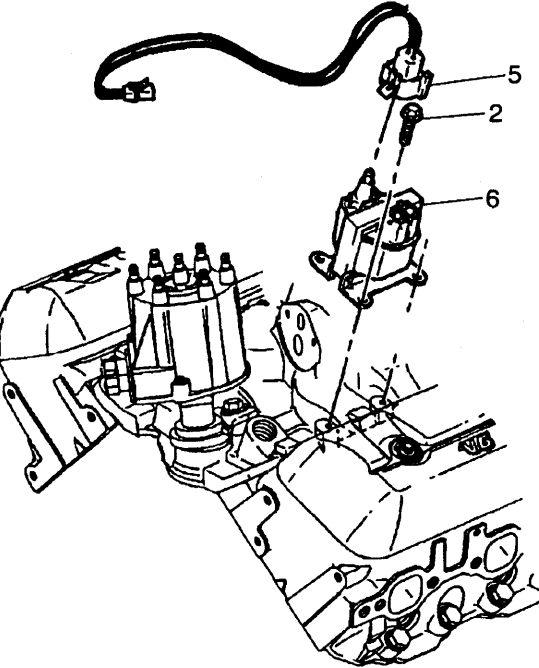
Install or Connect

A replacement ignition coil kit comes with two screws to attach the ignition coil to the bracket.

1. Ignition coil to the bracket with two screws.
2. Ignition coil bracket to the engine bracket with studs and nuts.
3. Ignition coil wire.
4. Electrical connectors.

IGNITION BASE TIMING

For directions on setting the ignition base timing, refer to the driveability and emissions section of NATP-9442.



SPARK PLUG REPLACEMENT

SERVICE PRECAUTIONS

- Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the spark plug to seize, causing damage to the cylinder head threads.
- Clean the spark plug recess area before removing the spark plug. Failure to do so can result in engine damage due to dirt or foreign material entering the cylinder head, or in contamination of the cylinder head threads. Contaminated threads may prevent proper seating of a new spark plug.
- Do not install spark plugs that are either "hotter" or "colder" than the heat range specified. Using spark plugs of the wrong heat range can severely damage the engine.



Remove or Disconnect

- Make sure the ignition switch is "OFF." position.
- 1. Air cleaner and engine air heat stove tube.
- 2. Air intake duct.

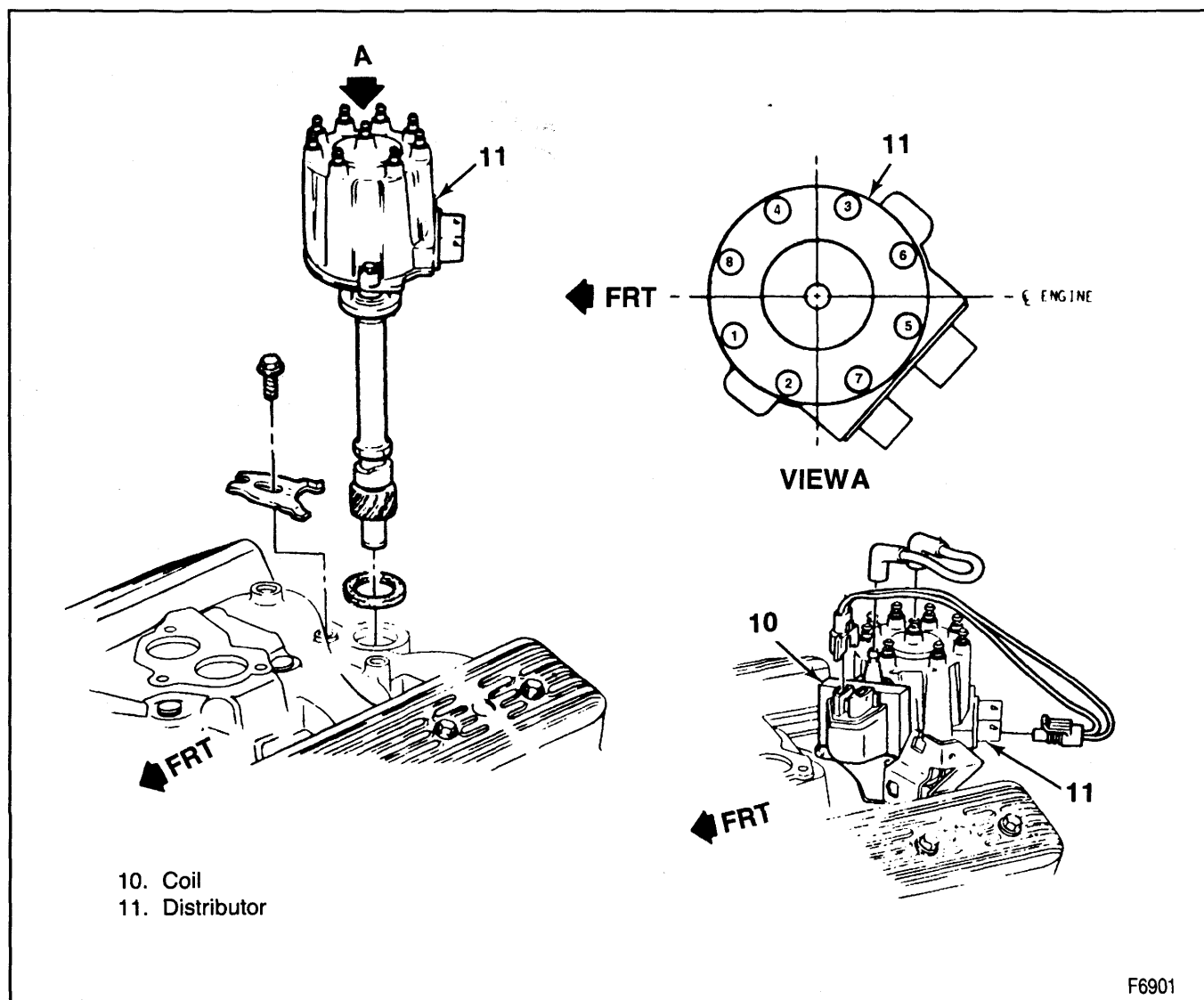


Figure 9—Distributor and Ignition Coil (5.0L and 5.7L Engines)

NOTICE: Twist the spark plug boot one-half turn to release it. Pull on the spark plug boot only. Do not pull on the spark plug wire or the spark plug lead may be damaged.

3. Spark plug wires and boots.
 - Label the spark plug wires.

NOTICE: These spark plugs have a ceramic insulator that is about 1/8 inch longer than earlier model plugs. Be sure to use a spark plug socket that is deep enough for this longer length spark plug. Failure to do so could cause cracking of the insulator and arcing inside the spark plug, resulting in engine miss.

4. Spark plugs.



Inspect

- Each spark plug for wear and gap. Refer to "Diagnosis of Spark Plugs."



Install or Connect

NOTICE: Make sure each spark plug threads smoothly into the cylinder head and is fully seated. Cross-threading or failing to fully seat spark plugs can cause overheating of the spark plugs, exhaust blow-by, or thread damage.

NOTICE: Refer to "Notice" on page 6D4-1.

1. Spark plugs.



Tighten

- Spark plugs to 15 N·m (11 lbs. ft.).
2. Spark plug wire and boot assemblies. Refer to "Spark Plug Wiring and Boots."
 3. Air cleaner and engine air heat stove tube.
 4. Air intake duct.

6D4-10 IGNITION SYSTEM

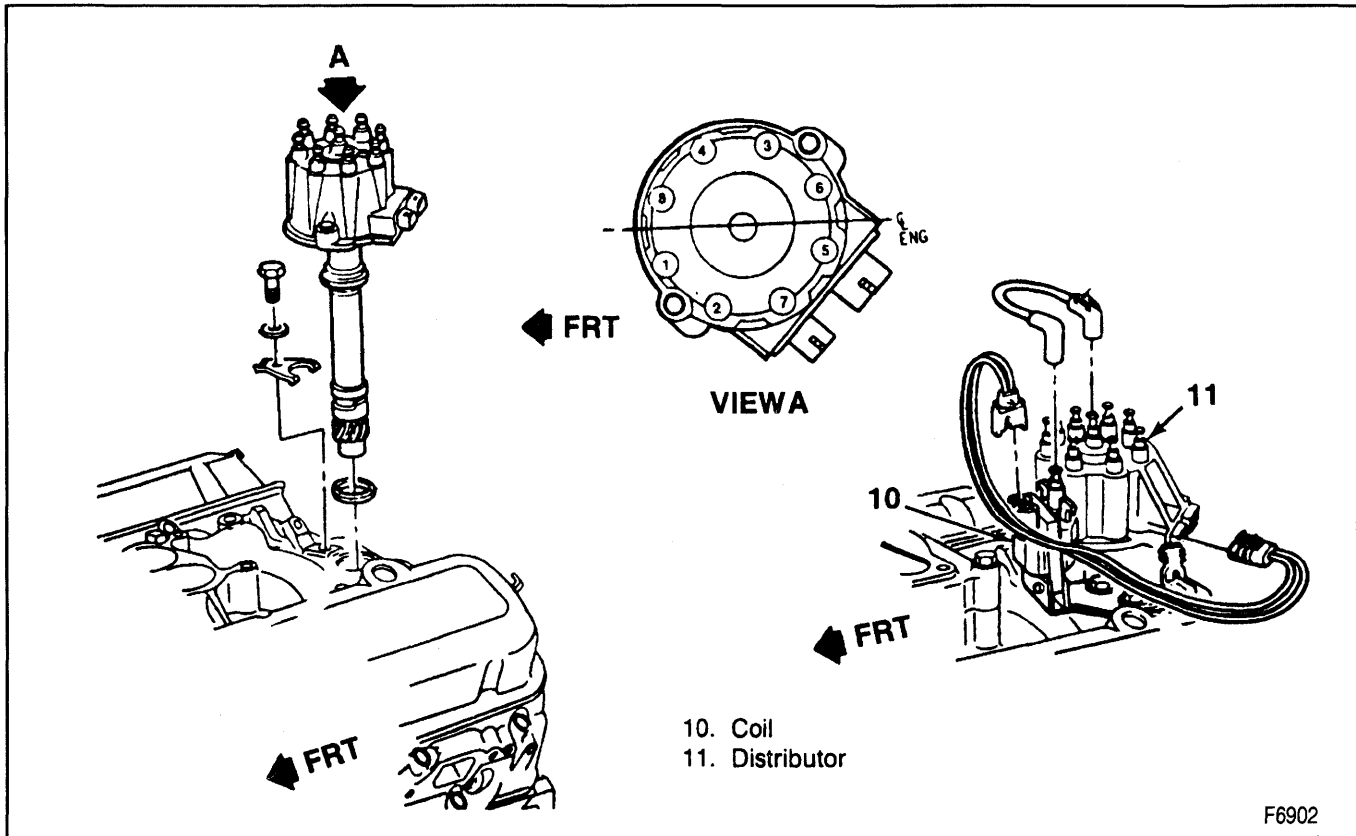


Figure 10—Distributor and Ignition Coil (7.4L Engine)

SPARK PLUG WIRING AND BOOTS

SERVICE PRECAUTIONS

1. Twist spark plug wire boots one-half turn before removing.
2. When removing the spark plug boot, do not use pliers or other tools that tear the spark plug boot.
3. Do not force anything between the spark plug wire and the boot, or through the silicone jacket of the wiring.
4. Do not pull on the spark plug wires to remove the spark plug boot. Pull on the spark plug boot, or use a tool designed for this purpose.
5. Use special care when installing spark plug boots to ensure the metal terminal within the boot is fully seated on the spark plug terminal and the boot has not moved on the wire.

NOTICE: If spark plug boot to wire movement has occurred, the spark plug boot will give a false visual impression of being fully seated. Make sure that spark plug boots have been properly assembled by pushing sideways on the installed spark plug boots. Failure to properly seat the terminal onto the spark plug will lead to wire core erosion and result in an engine misfire or crossfire condition, and possible internal damage to the engine.

- If they have been correctly installed, a stiff spark plug boot with only slight looseness will be noted. If the terminal has not been properly seated on the spark plug, only the resistance of the spark plug boot will be felt when pushing sideways.

SPARK PLUG WIRE REPLACEMENT

Spark plug wire routings must be kept intact during service and followed exactly when spark plug wires have been disconnected or when replacement of the spark plug wires is necessary. Failure to route the spark plug wires properly can lead to radio noise and crossfiring of the spark plugs, or shorting of the leads to ground. The correct routing for each engine is shown in figures 11 through 14.

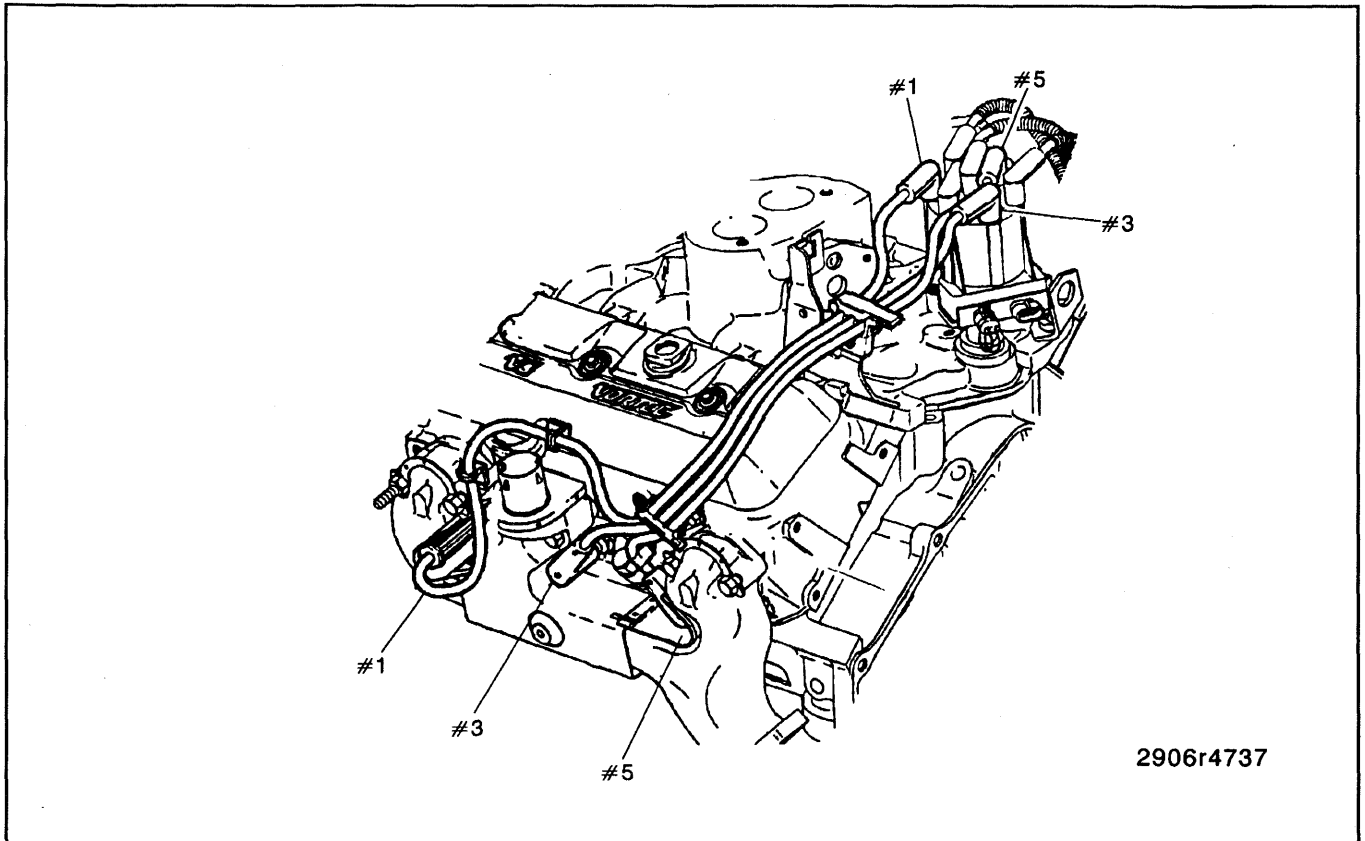


Figure 11—Spark Plug Wire Routing - Left Side (4.3L VIN Z)

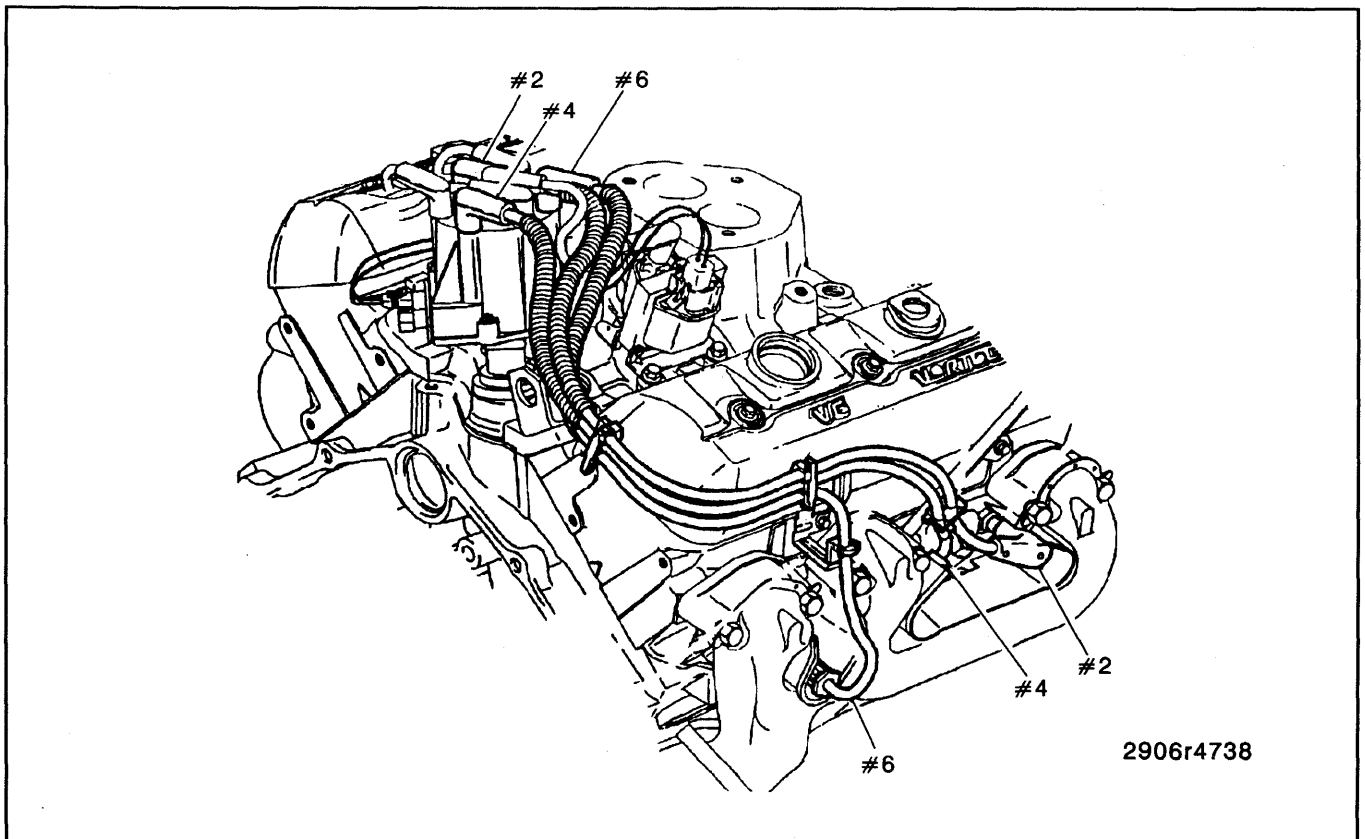


Figure 12—Spark Plug Wire Routing - Right Side (4.3L VIN Z)

6D4-12 IGNITION SYSTEM

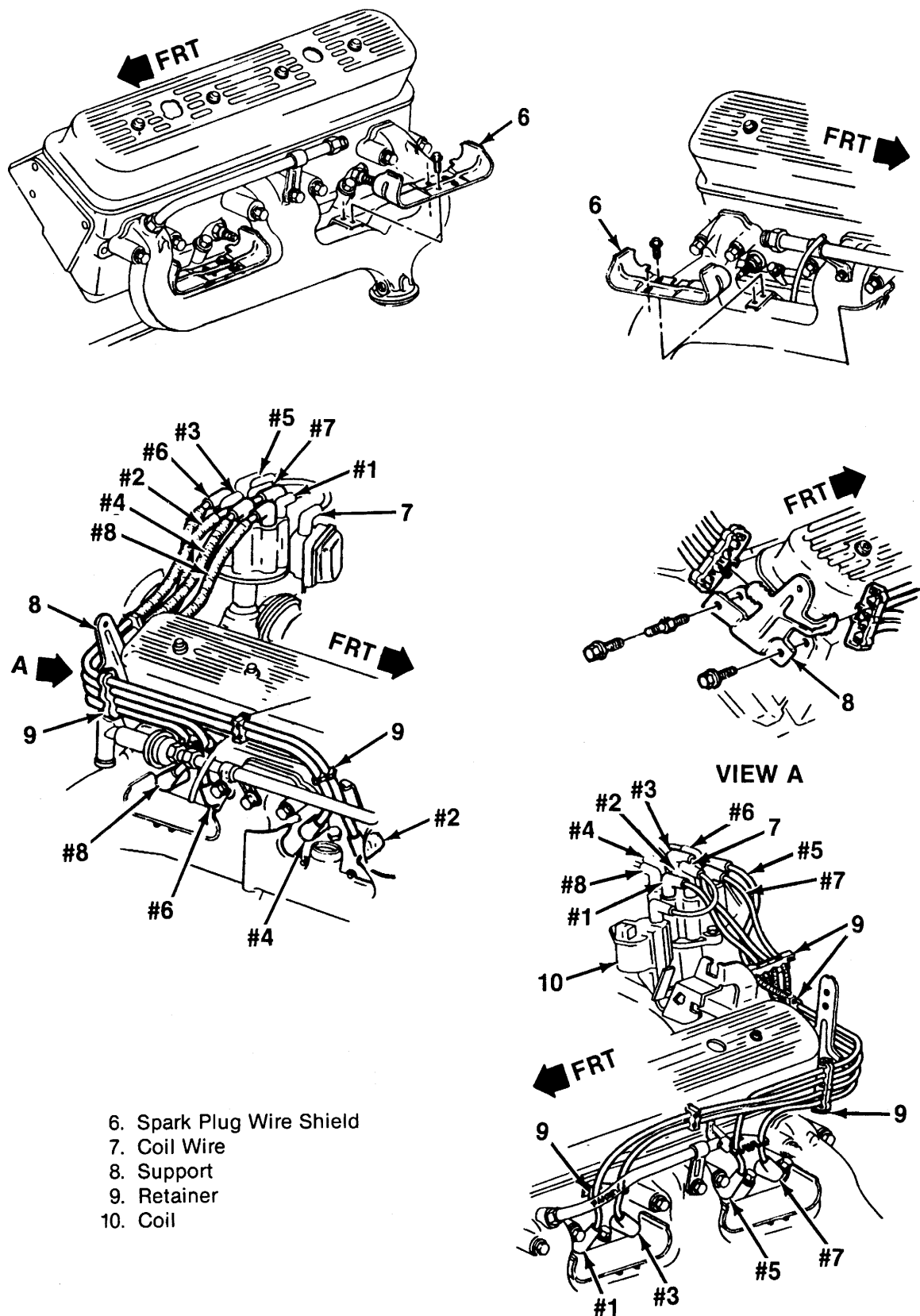


Figure 13—Spark Plug Wire Routing (5.0L and 5.7L Engines)

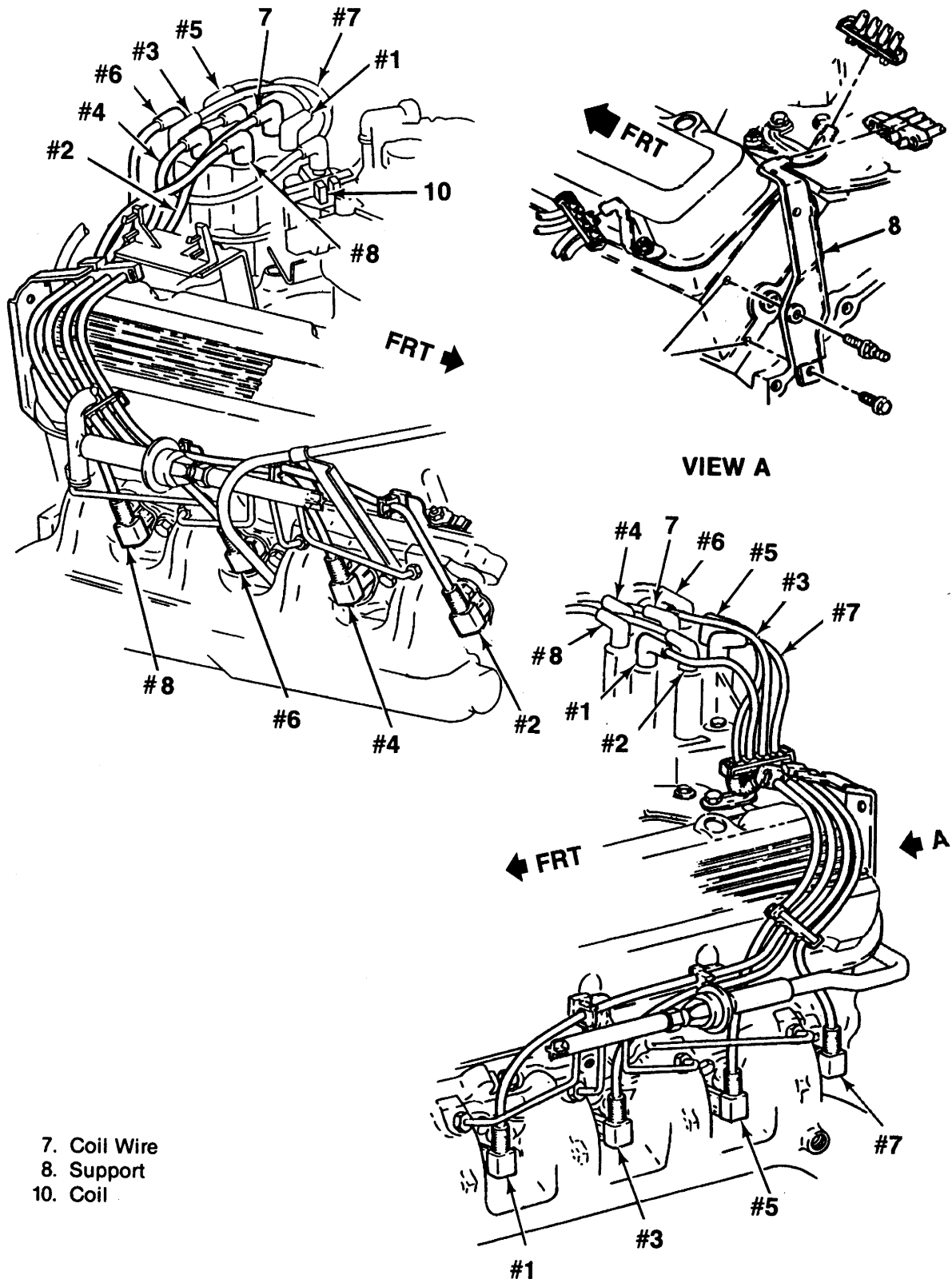


Figure 14—Spark Plug Wire Routing (7.4L Engine)

SPECIFICATIONS
SPARK PLUGS

Spark Plug Usage..... Refer to Section OB
Spark Plug Gap..... Refer to "Vehicle Emission Control Information" label in the engine compartment.

FASTENER TIGHTENING SPECIFICATIONS

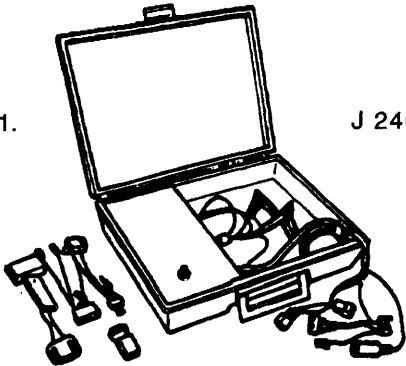
ITEM	N·m	Lbs. Ft.	Lbs. In.
Distributor Hold-down Bolt.....	27	20	—
Ignition Coil Hold-down Bolt.....	27	20	—
Ignition Coil Hold-down Nut	27	20	—
Spark Plugs.....	15	11	—

T3145

SPECIAL TOOLS

1. MODULE TESTER

1.



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SECTION 6D5**ENGINE WIRING**

When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach some component, take care that all wiring is replaced in its original position and all harnesses are routed correctly. If clips or retainers break, replace them. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions or from being rerouted. Refer to figures 1 through 21 for the correct routing of the engine wiring.

6D5-2 ENGINE WIRING

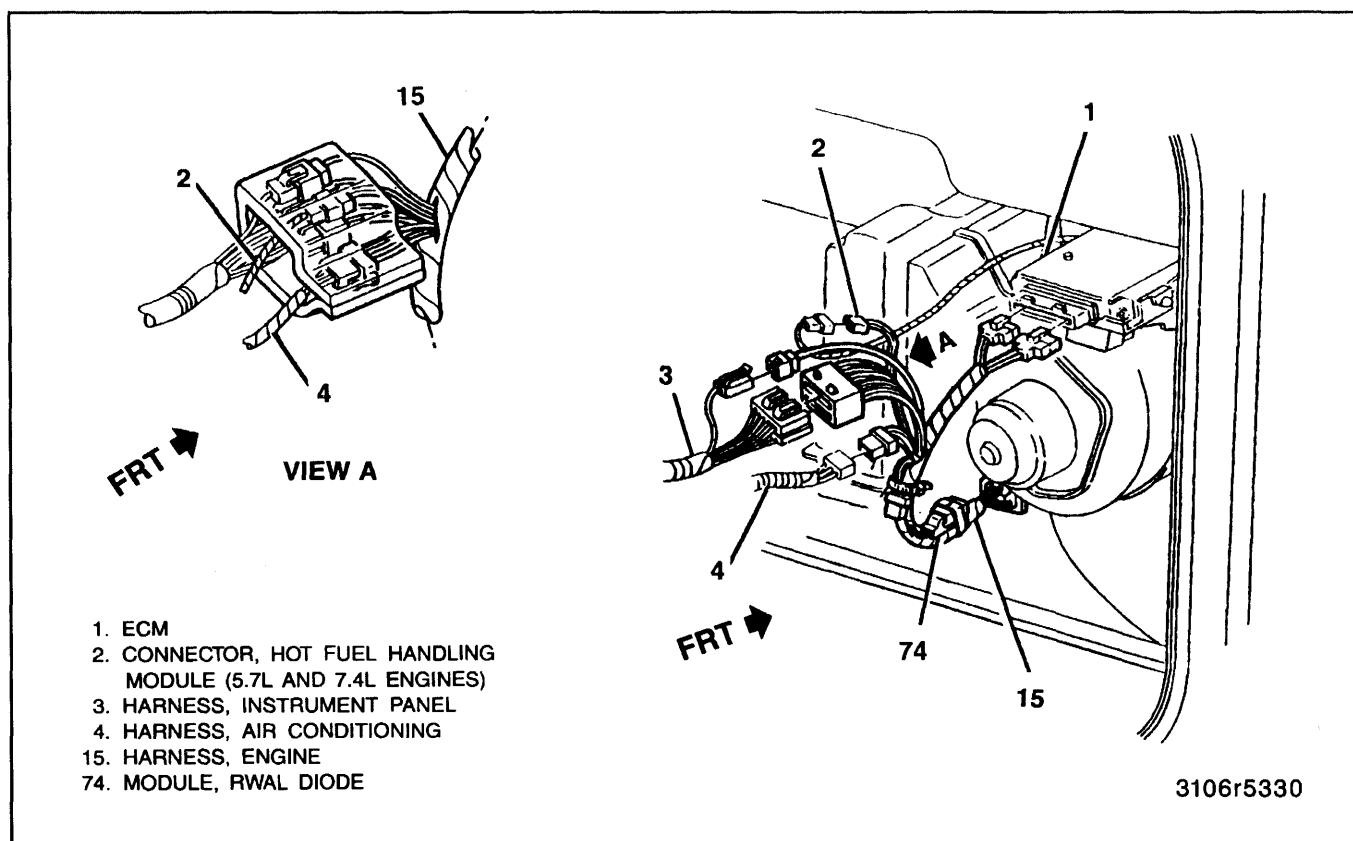


Figure 1—Engine Wiring to the Control Module (Gas Engines)

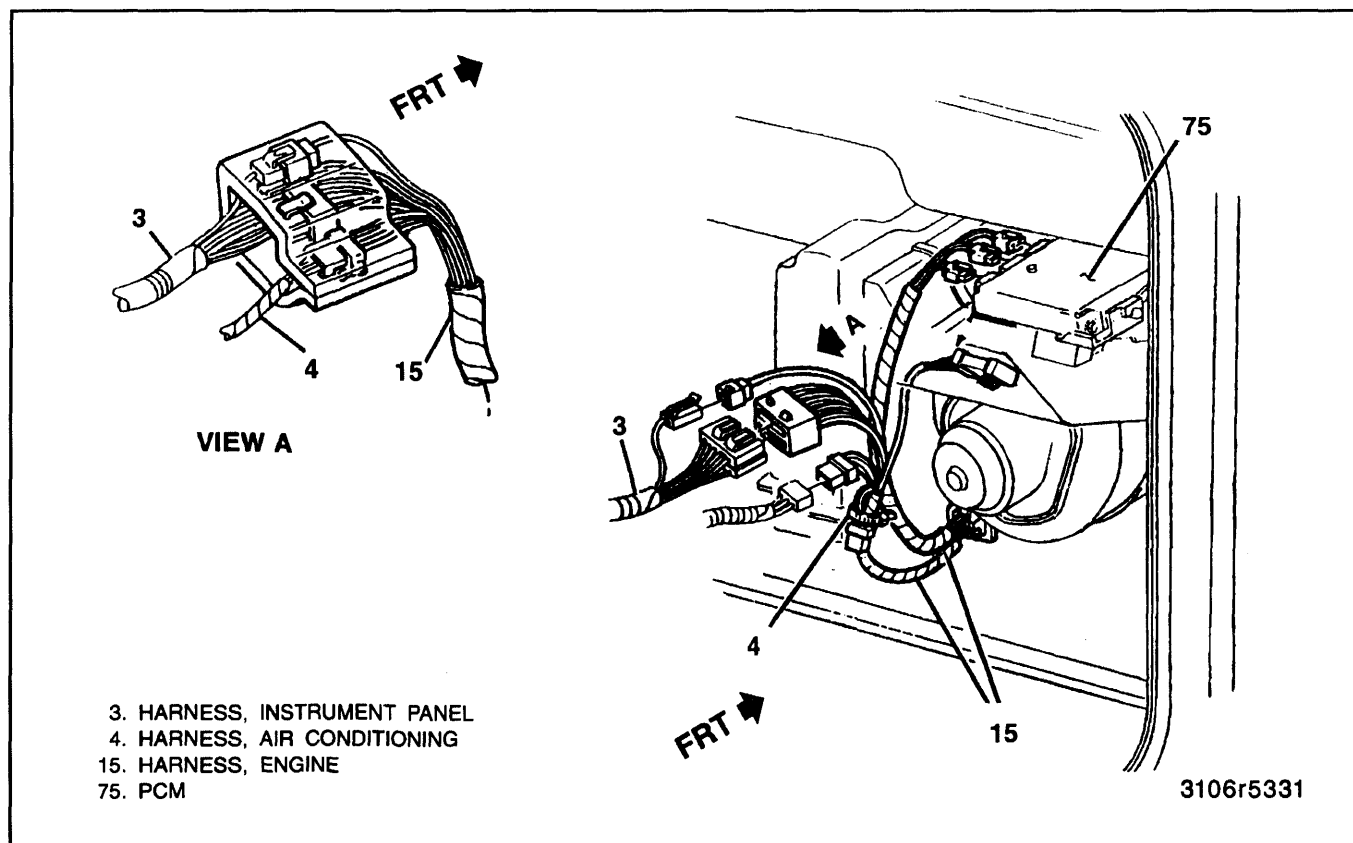


Figure 2—Engine Wiring to the Control Module (Diesel Engines)

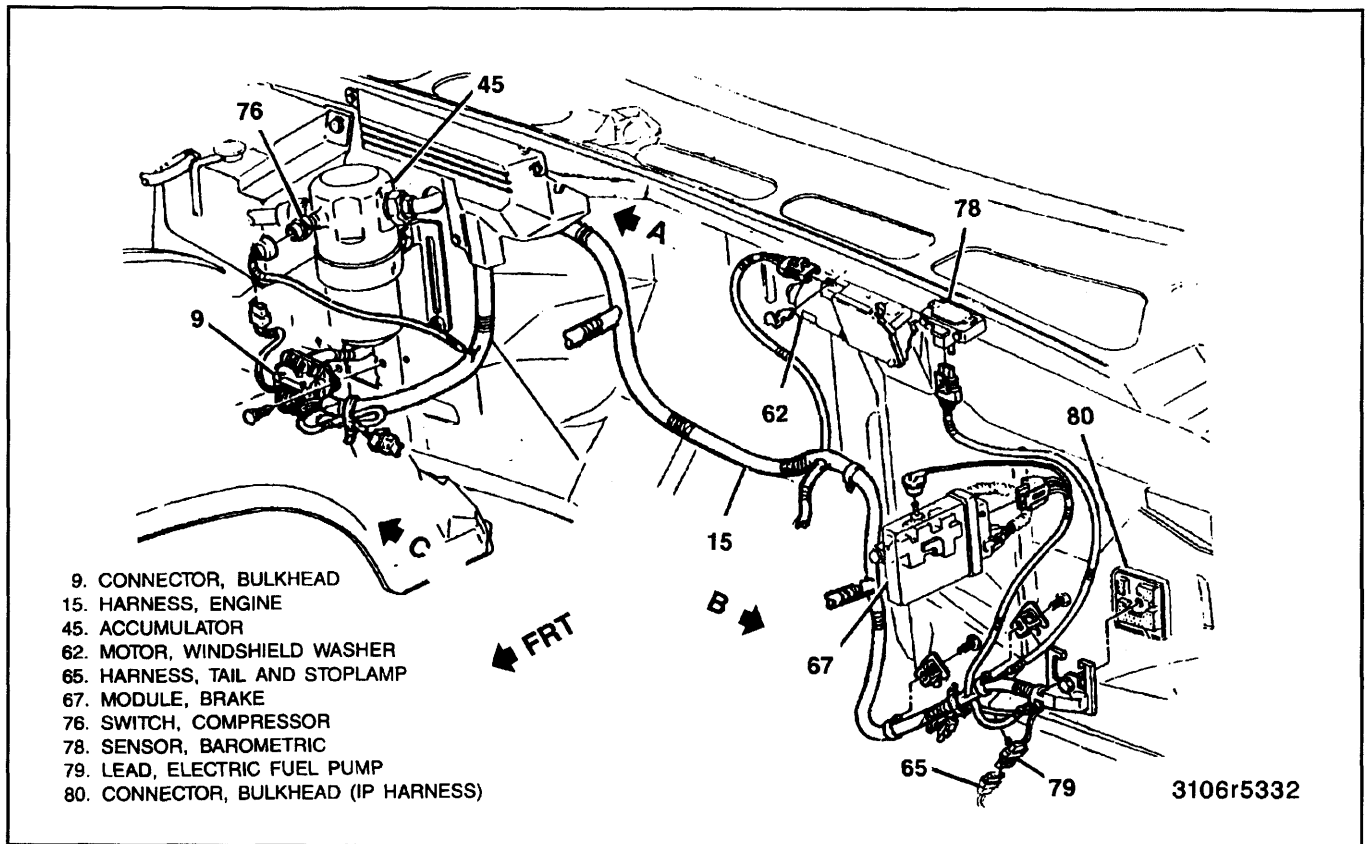


Figure 3—Engine Wiring at the Cowl

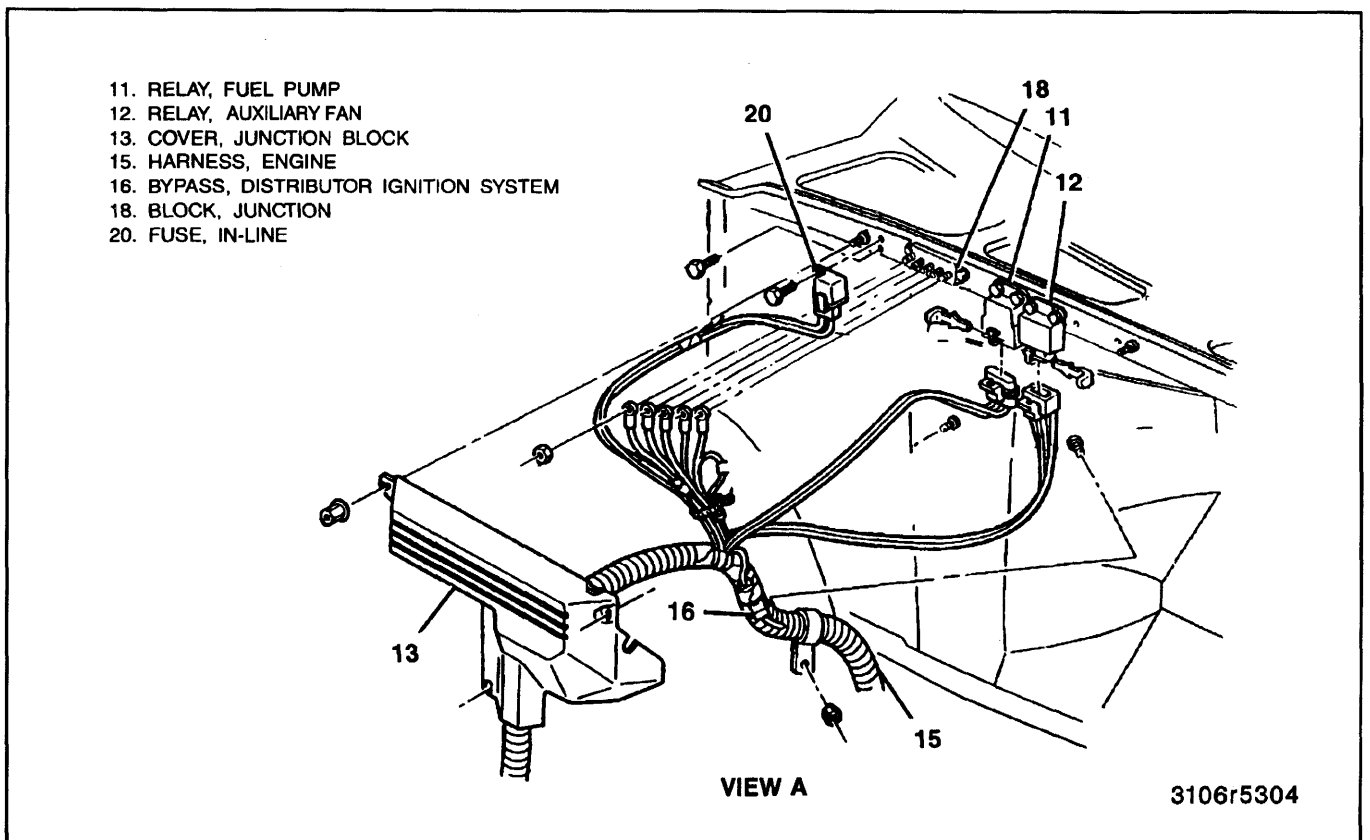


Figure 4—Engine Wiring to the Instrument Panel (1 of 3)

6D5-4 ENGINE WIRING

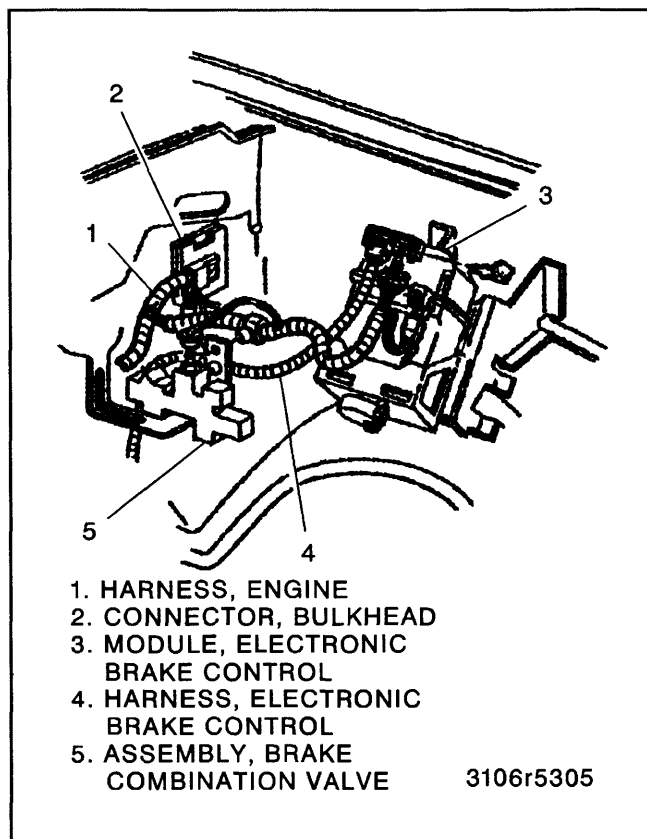


Figure 5—Engine Wiring to the Instrument Panel
(2 of 3)

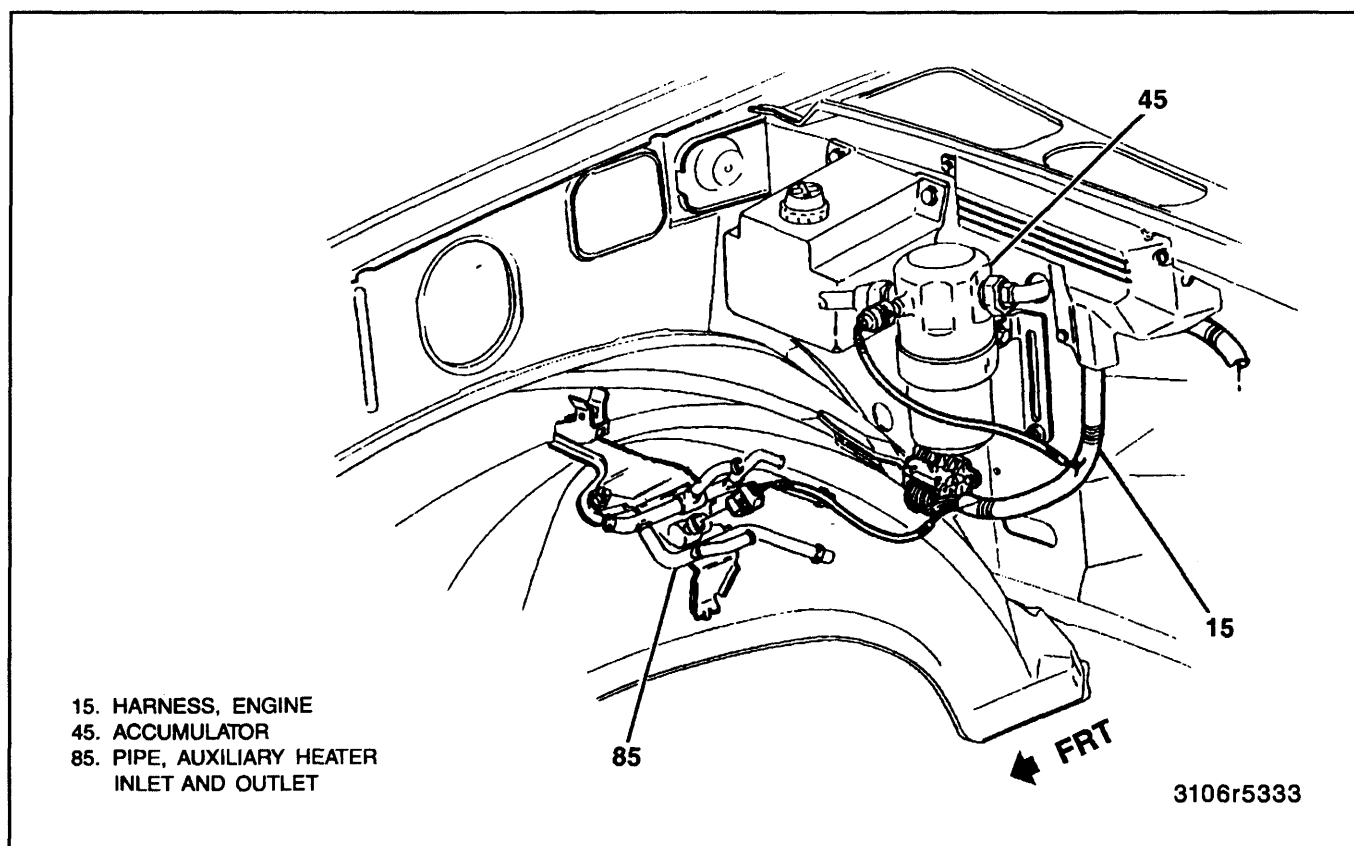


Figure 6—Engine Wiring to the Instrument Panel (3 of 3)

- 22. SWITCH, ECT
- 25. SENSOR, KNOCK
- 29. GROUND, ENGINE HARNESS
- 30. GENERATOR
- 33. SOLENOID, STARTER
- 36. SENSOR, THROTTLE POSITION
- 37. SOLENOID, EGR
- 38. INJECTOR, TBI
- 86. ACTIVATOR, IDLE AND AIR CONTROL

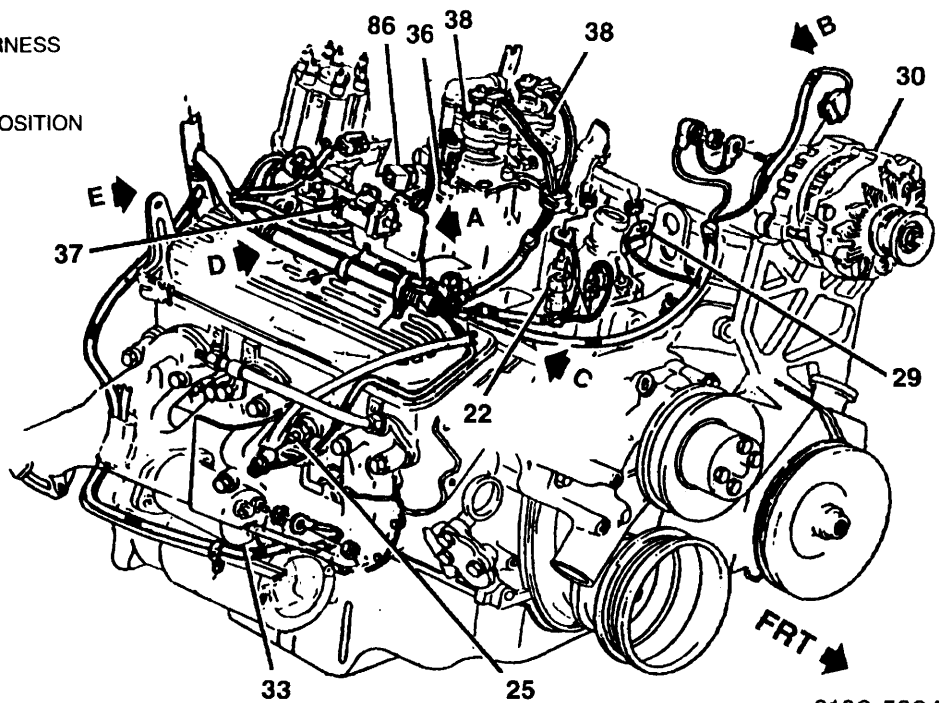


Figure 7—Engine Wiring (4.3L VIN Z)

6D5-6 ENGINE WIRING

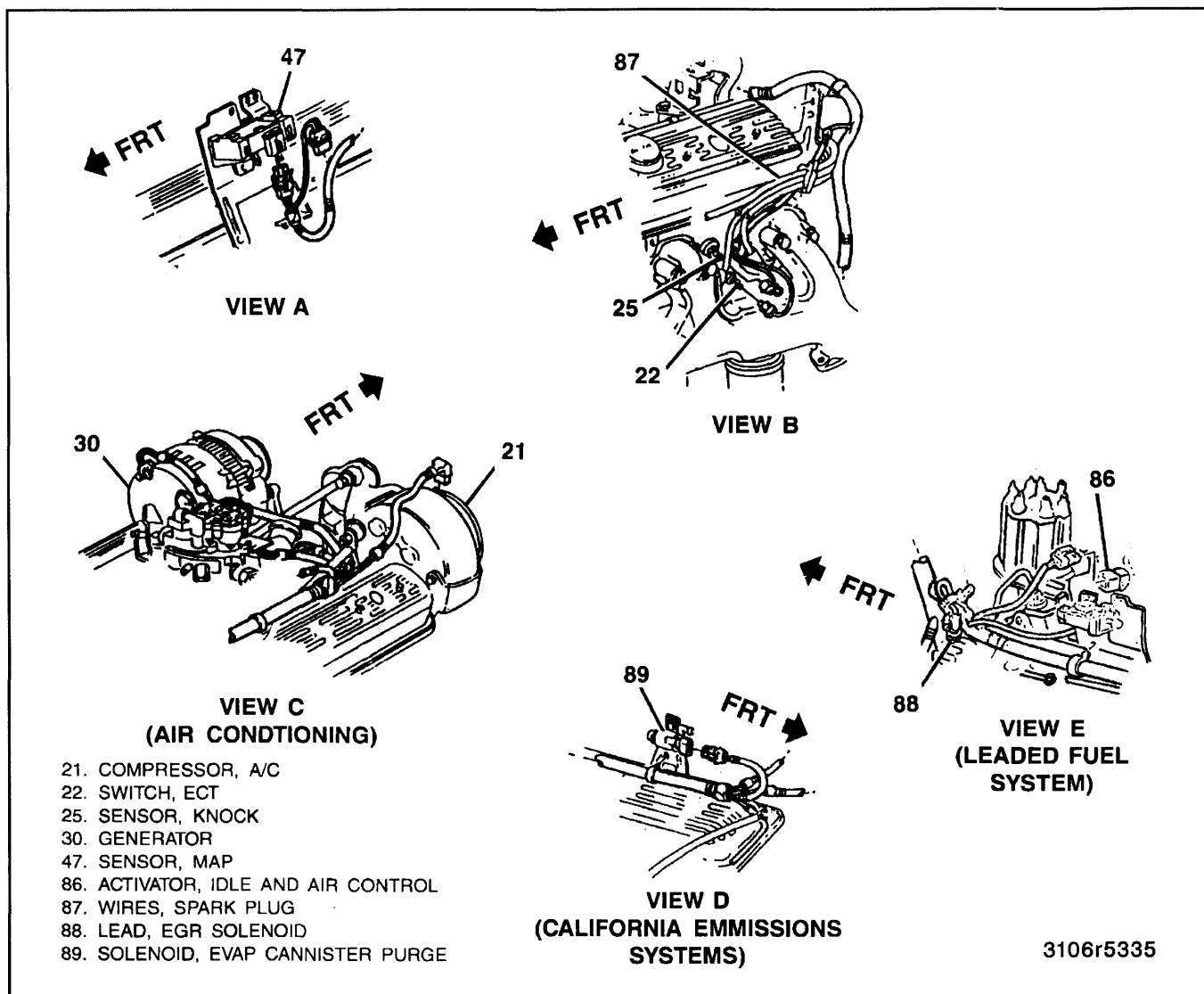


Figure 8—Engine Wiring Views (4.3L VIN Z)

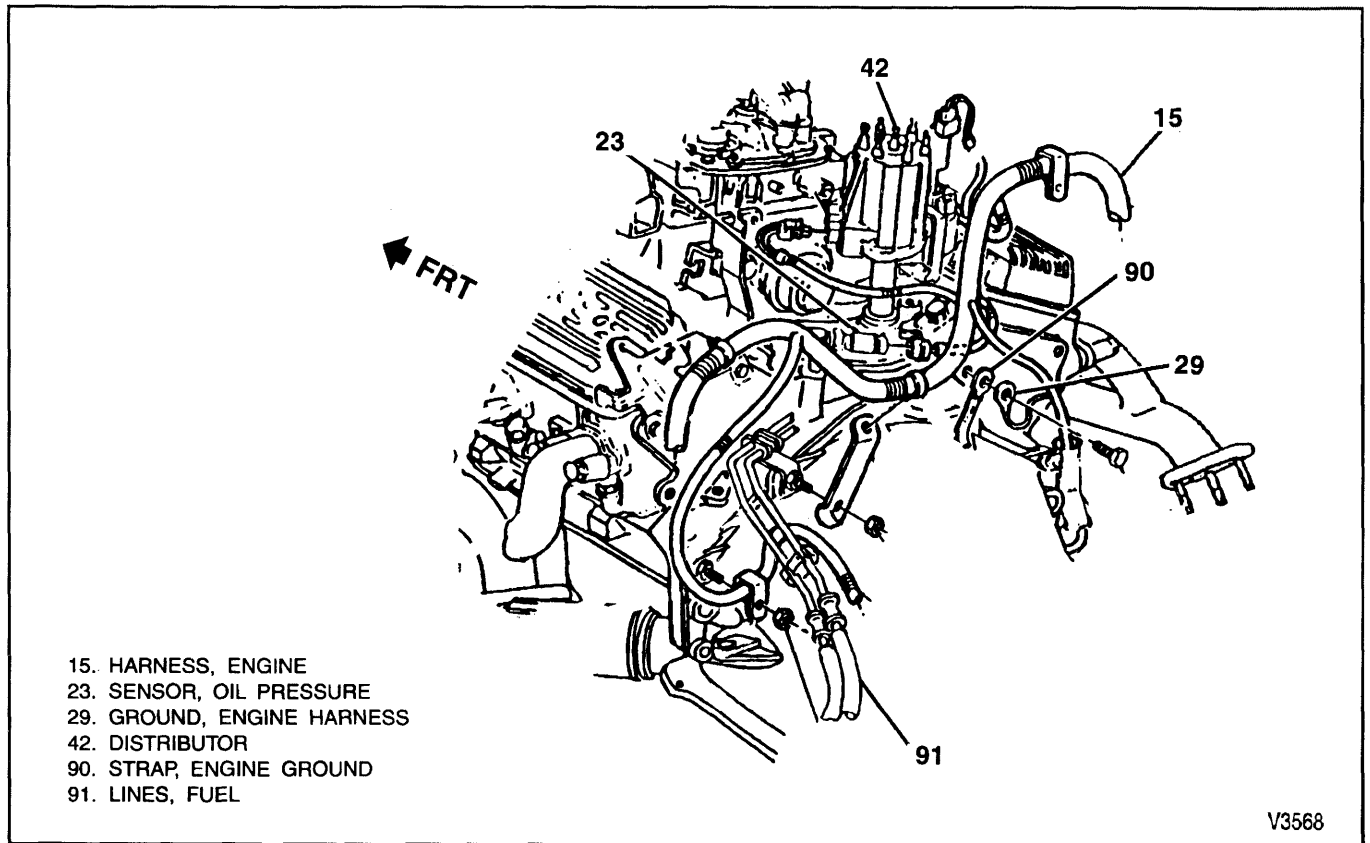


Figure 9—Engine Wiring - Rear (4.3L VIN Z)

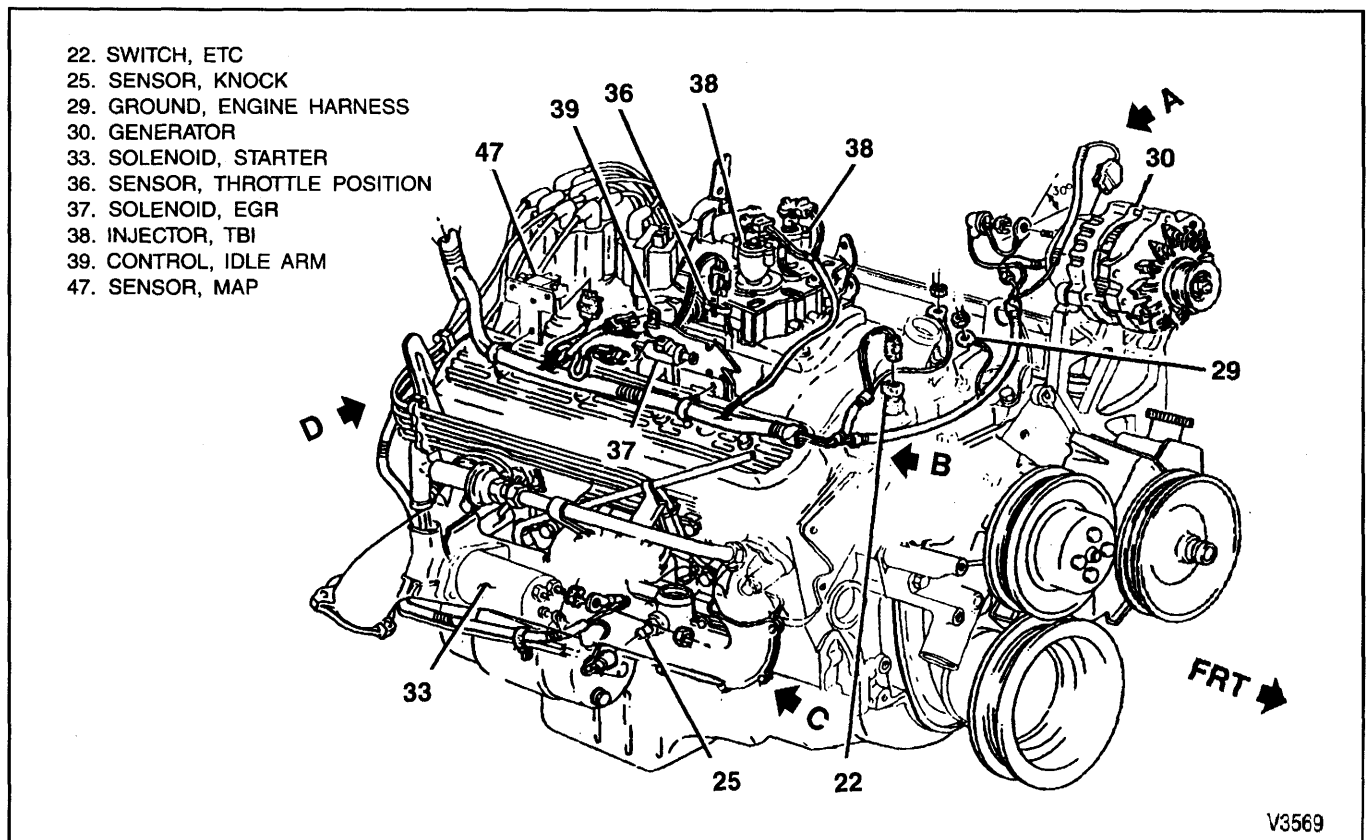
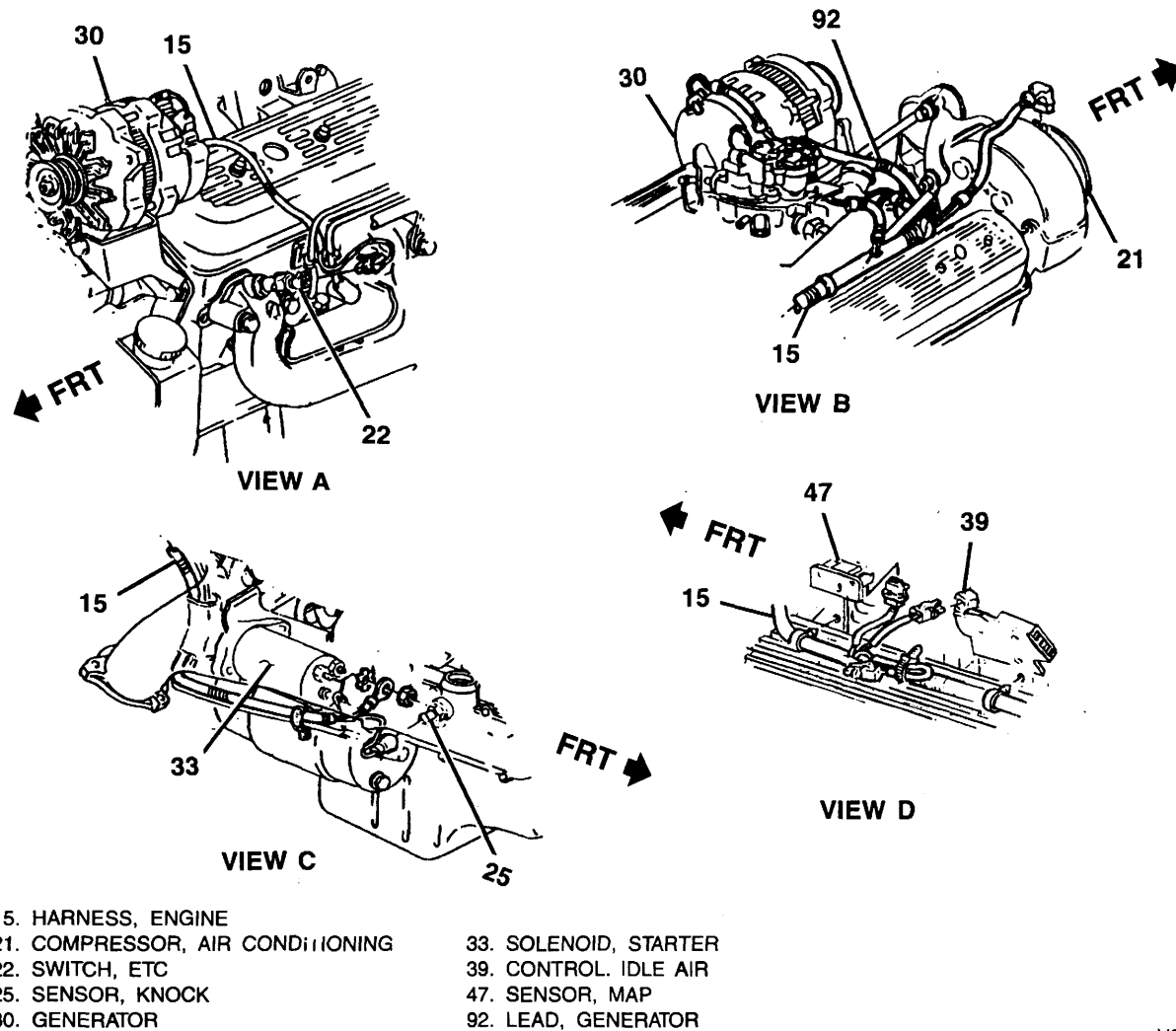


Figure 10—Engine Wiring - Right and Left Sides (5.0L VIN H and 5.7L VIN K)

6D5-8 ENGINE WIRING



V3570

Figure 11—Engine Wiring - Right and Left Side Views (5.0L VIN H and 5.7L VIN K)

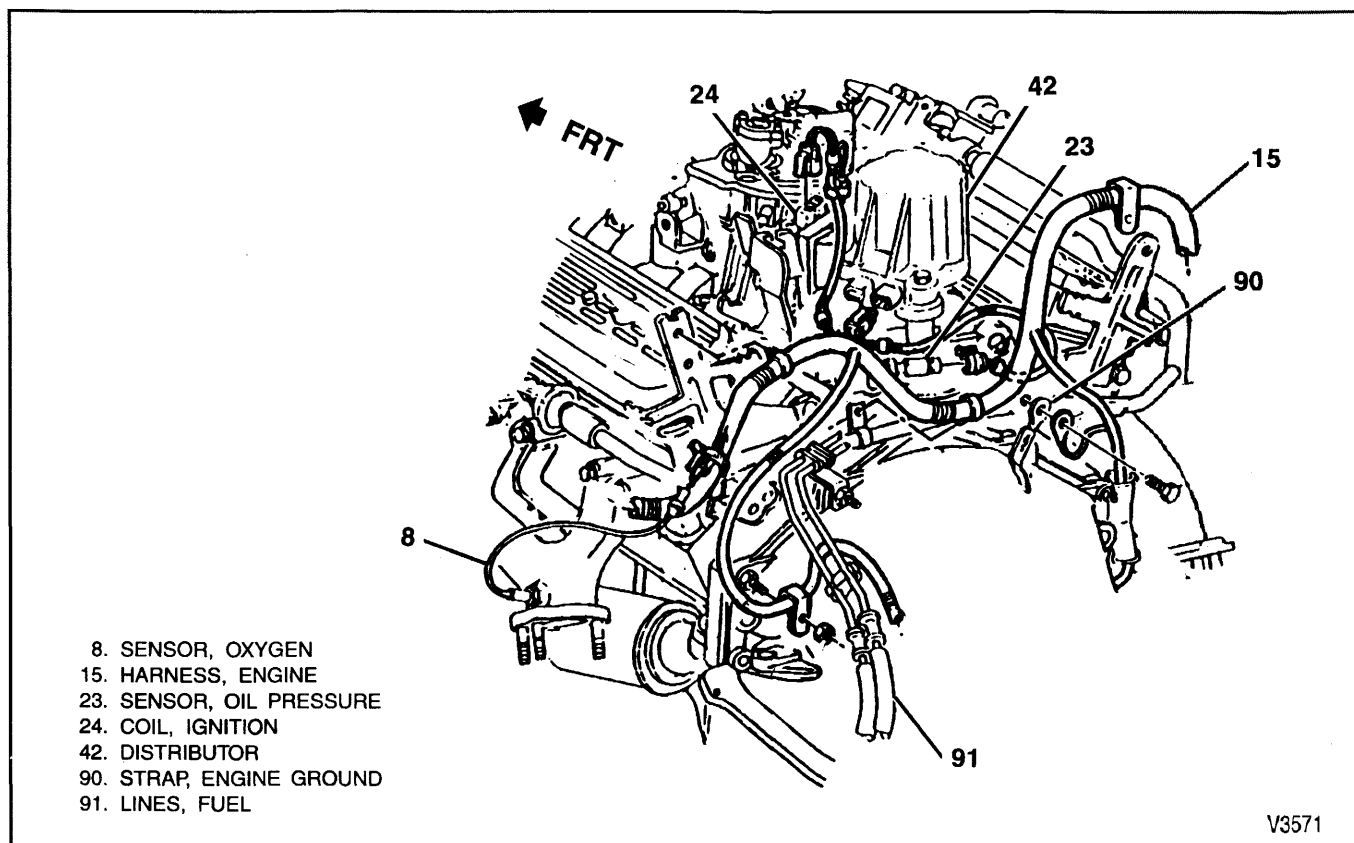


Figure 12—Engine Wiring - Rear (5.0L VIN H and 5.7L VIN K)

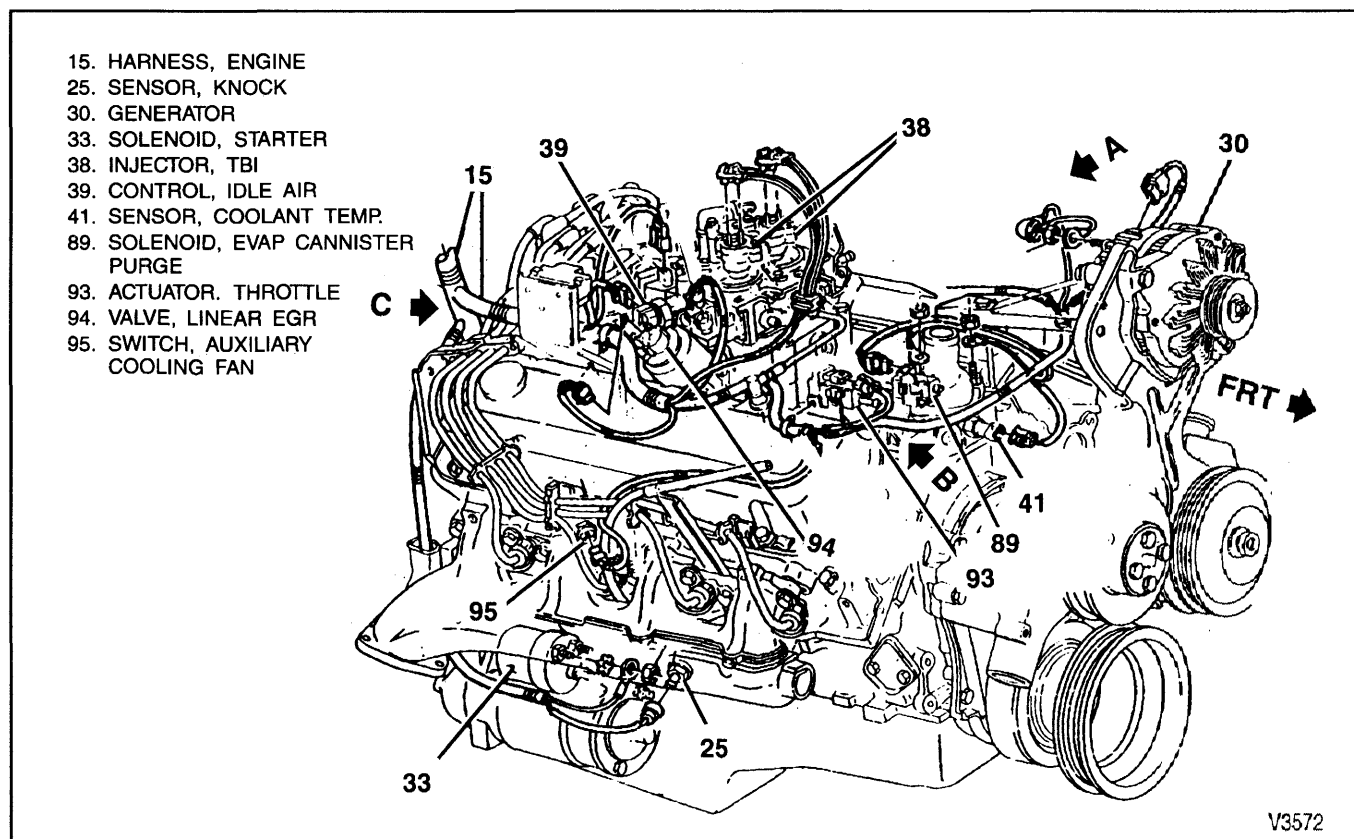


Figure 13—Engine Wiring - Right and Left Sides (7.4L VIN N)

6D5-10 ENGINE WIRING

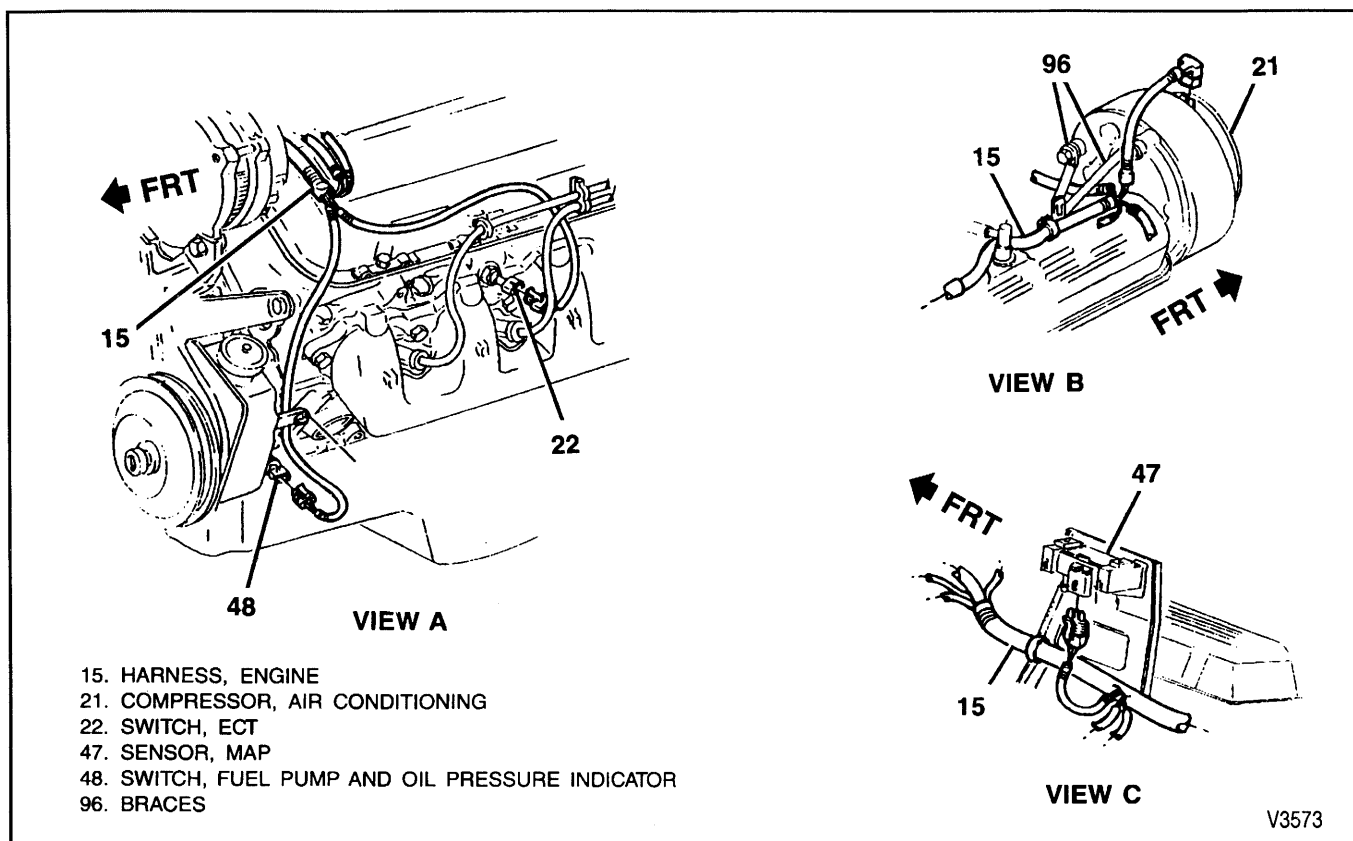


Figure 14—Engine Wiring - Right and Left Side Views (7.4L VIN N)

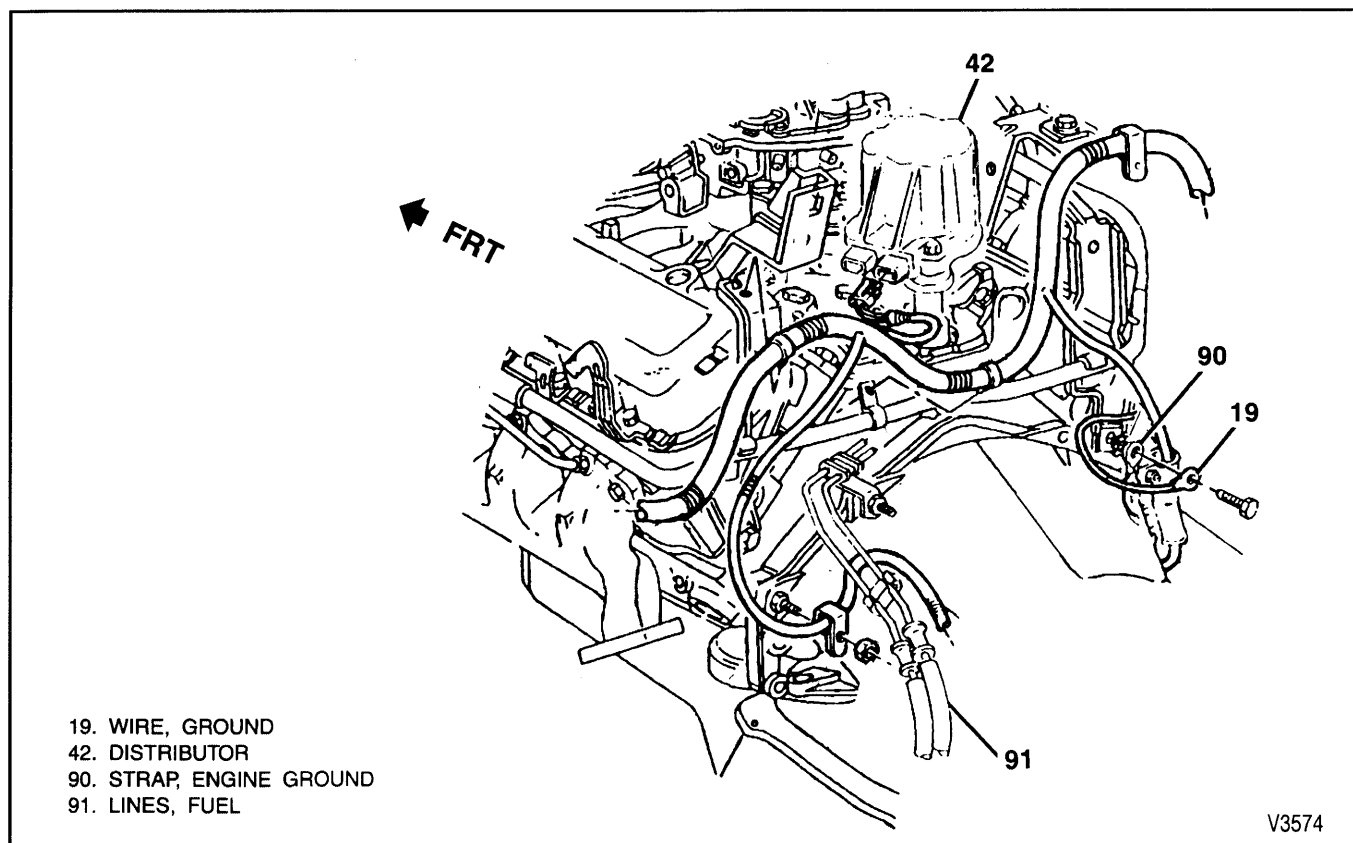
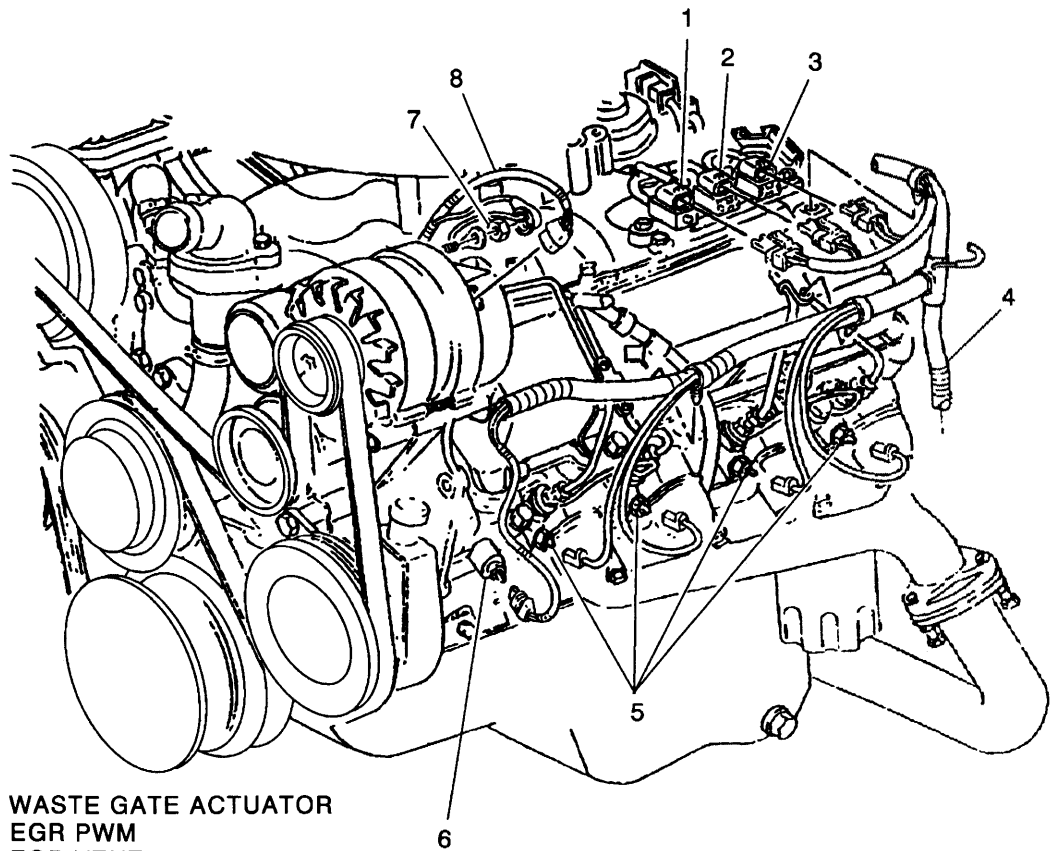


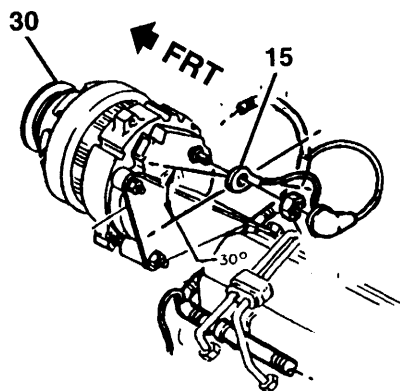
Figure 15—Engine Wiring - Rear (7.4L VIN N)



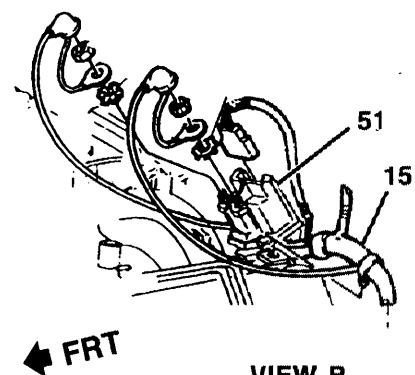
1. SOLENOID, WASTE GATE ACTUATOR
2. SOLENOID, EGR PWM
3. SOLENOID, EGR VENT
4. HARNESS, ENGINE TO INSTRUMENT PANEL
5. GLOW PLUGS
6. SWITCH, ENGINE COOLANT TEMPERATURE INDICATOR
7. NUT, 6 N·m (53 LBS. IN.)
8. HARNESS, ENGINE TO GENERATOR

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Figure 16—Engine Wiring - Left Side (6.5L Diesel Engines)



VIEW A



VIEW B

15. HARNESS, ENGINE
30. GENERATOR
51. CONTROLLER, GLOW PLUG

V3576

Figure 17—Engine Wiring - Left Side Views (6.5L Diesel Engines)

6D5-12 ENGINE WIRING

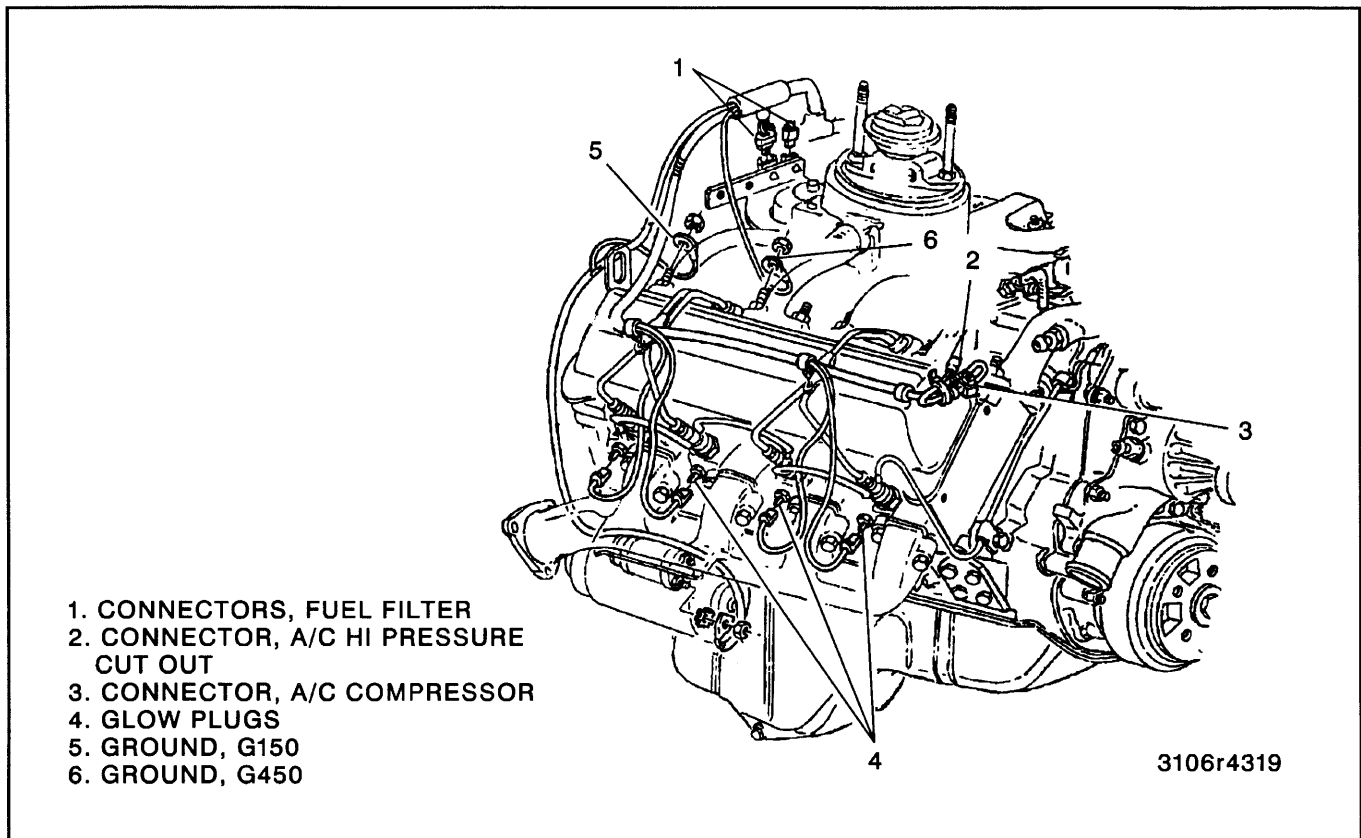
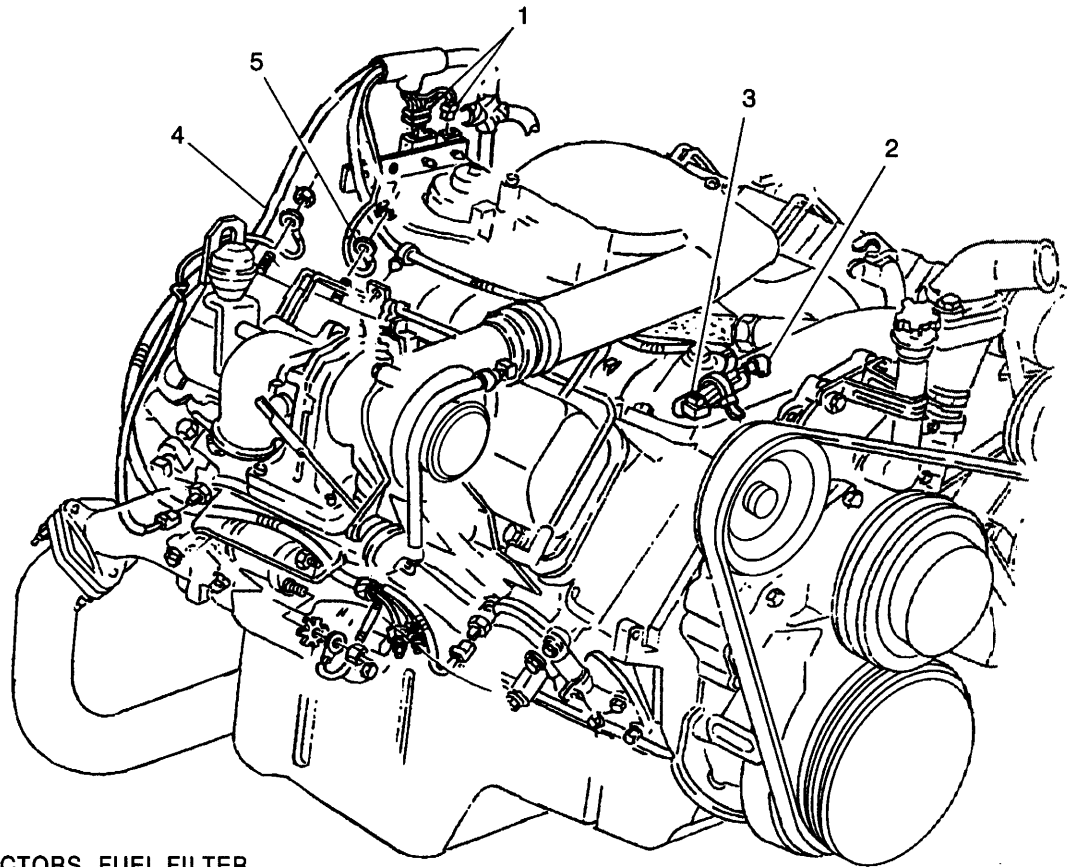


Figure 18—Engine Wiring - Right Side (6.5L VIN P)



- 1. CONNECTORS, FUEL FILTER
- 2. CONNECTOR, A/C HI PRESSURE CUT - OUT SWITCH
- 3. CONNECTOR, A/C COMPRESSOR
- 4. GROUND, G150
- 5. GROUND, G450

3106r4382

Figure 19—Engine Wiring - Right Side (6.5L VIN S AND F)

6D5-14 ENGINE WIRING

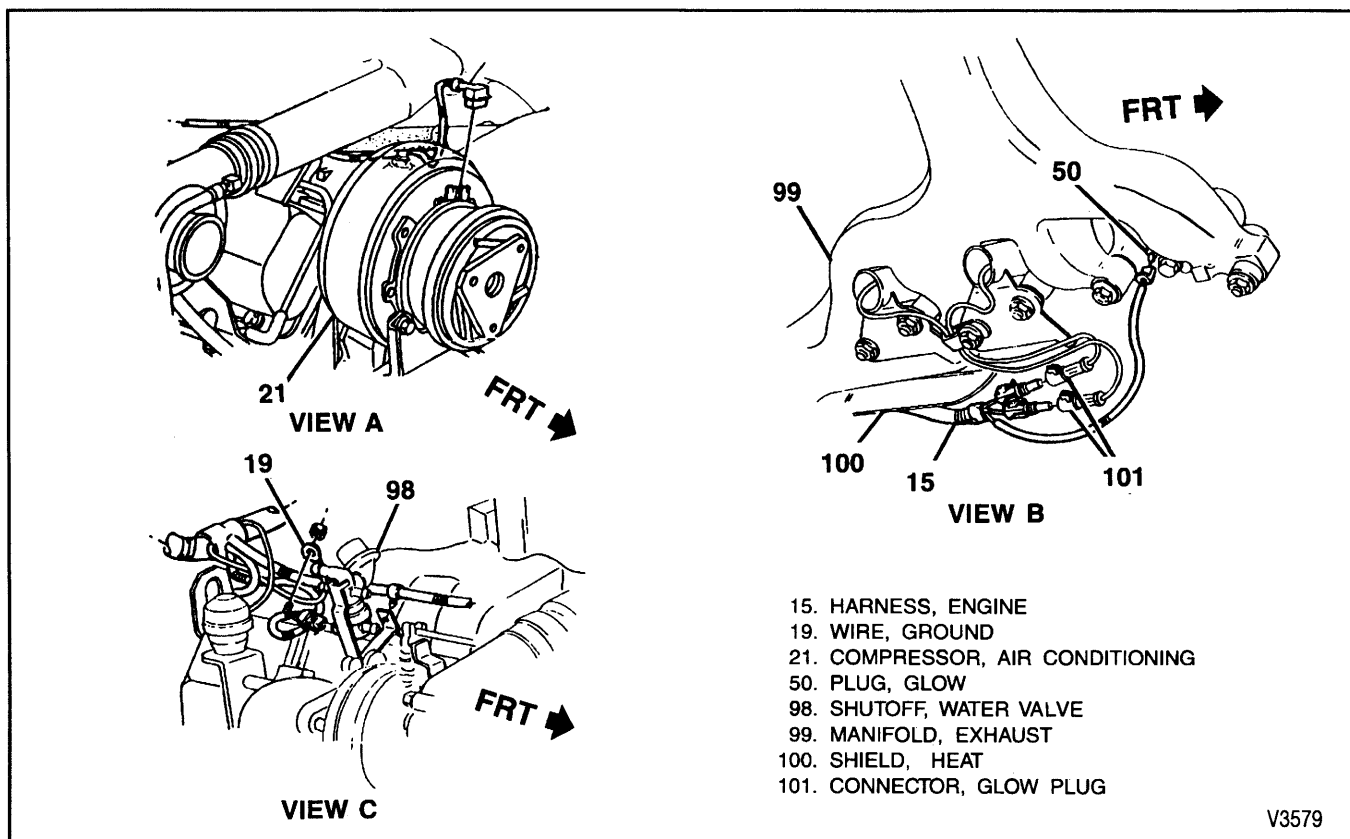


Figure 20—Engine Wiring - Right Side Views (6.5L Diesel)

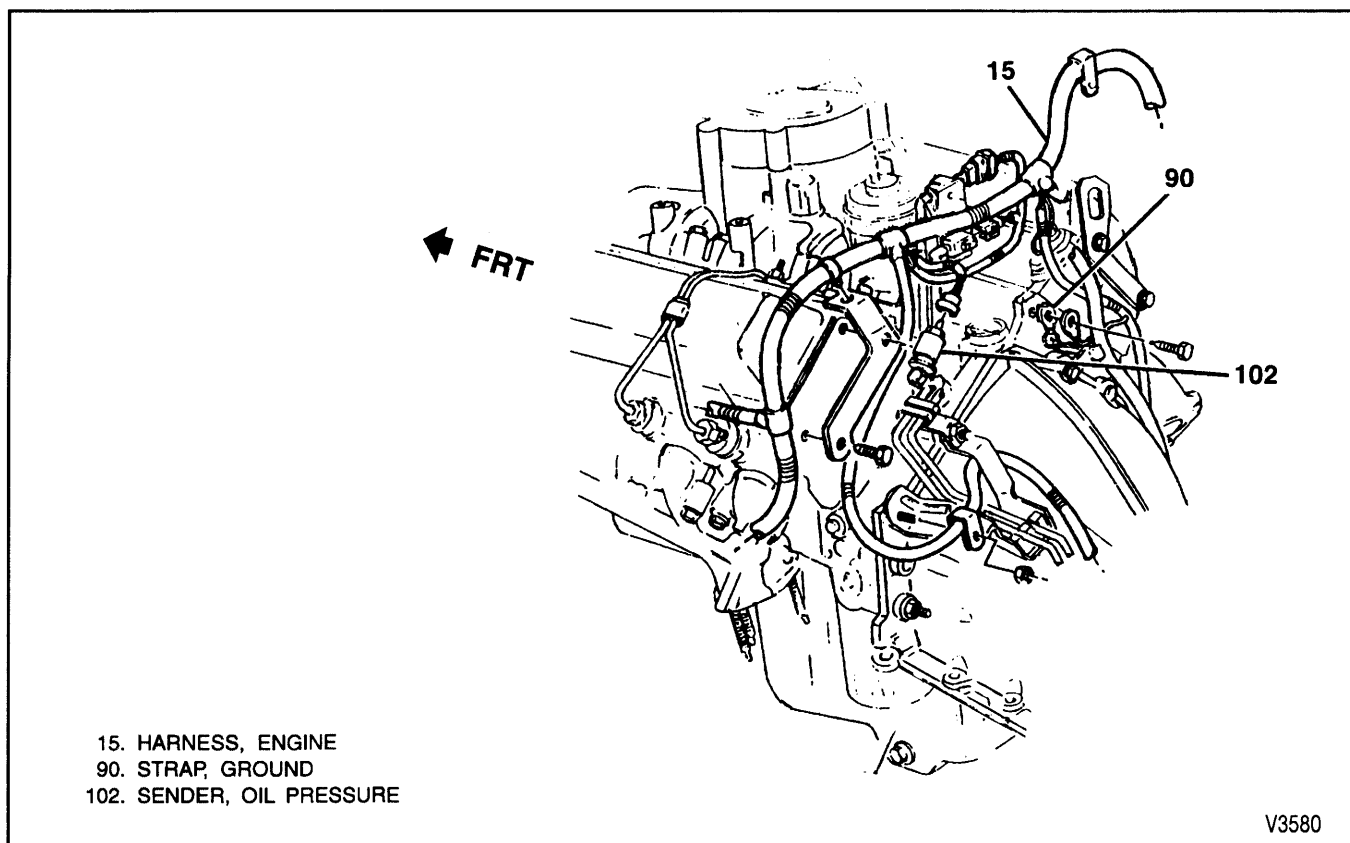


Figure 21—Engine Wiring - Rear (6.5L Diesel)

SECTION 6D6

**DIESEL GLOW PLUG
ELECTRICAL SYSTEM**

There are three versions of the 6.5L diesel available with these vehicles. They include: the naturally aspirated (RPO L49, VIN P), the turbocharged light duty (RPO L56, VIN S), and the turbocharged heavy duty (RPO L65, VIN F). These engines use an electronically-controlled injector pump and glow plug electrical system. For diagnosis, refer to the fuel and emission section of NATP-9442.

NOTES

SECTION 6E

EMISSIONS

The gasoline engines used in these vehicles use a throttle body fuel injection (TBI) unit. For information about throttle body fuel injection and engine emission systems, refer to the gas engine fuel and emissions section of NATP-9442.

NOTES

SECTION 6E2

DIESEL EMISSIONS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

SUBJECT	PAGE
General Description	6E2-1
Crankcase Ventilation System	6E2-1
Vacuum Pump	6E2-1
Diagnosis	6E2-3
CDR Valve Test	6E2-3
On-Vehicle Service	6E2-3
CDR Valve and Hoses	6E2-3
Special Tools	6E2-4

GENERAL DESCRIPTION

The 6.5L diesel engine has controls to reduce emissions while maintaining good driveability and fuel economy. The light duty naturally aspirated engine (L49, VIN P) comes equipped with the following controls:

- A. Crankcase ventilation system.
- B. Powertrain control module.
- C. Vacuum pump (L49, VIN P)
- D. Exhaust gas recirculation (EGR).
- E. Cold advance and glow plug control.
- F. Automatic transmission control.

CRANKCASE VENTILATION SYSTEM

The crankcase ventilation system is designed to reduce the crankcase pressure at idle. This lower pressure reduces engine oil leaks. The system consists of a crankcase depression regulator valve located on the right valve cover (figure 1).

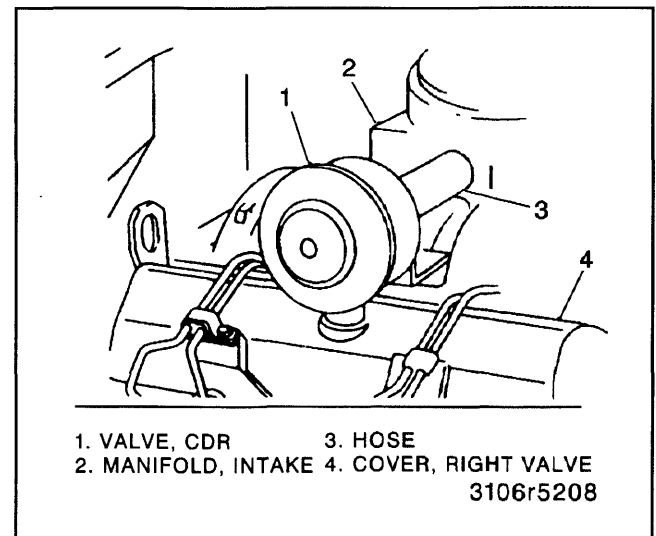
The crankcase depression regulator (CDR) valve is used to regulate the flow of crankcase gases back into the engine. The valve is designed to limit vacuum in the crankcase as the gases are drawn from the right valve cover, through the valve, and into the intake manifold (figure 2).

The intake manifold vacuum acts against a spring loaded diaphragm to control the flow of crankcase gases. Higher intake vacuum levels pull the diaphragm closer to the top of the outlet tube. This reduces the amount of gases being drawn from the crankcase and decreases the vacuum level in the crankcase. As the intake vacuum decreases, the spring pushes the diaphragm away from the top of the outlet tube allowing

more gases to flow to the intake manifold (figure 3). For information about the Diagnostic Trouble Codes (DTC), refer to the Driveability, Emissions and Electrical Diagnosis Manual, NATP-9442.

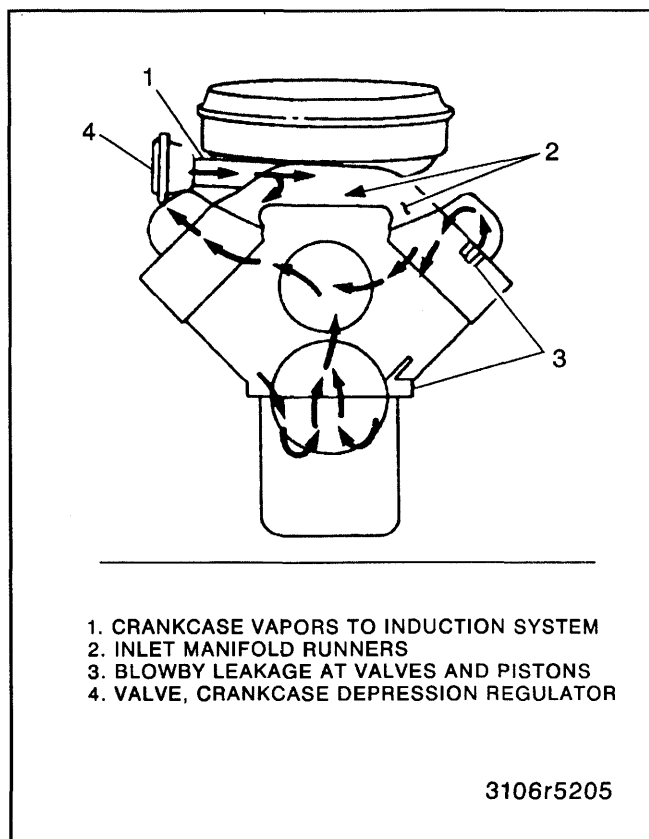
VACUUM PUMP

A vacuum pump is located on the front right side of the engine and provides a vacuum source to operate the EGR system for the light duty naturally aspirated engine (L49, VIN P) and air conditioning servos (if equipped) (figure 4).

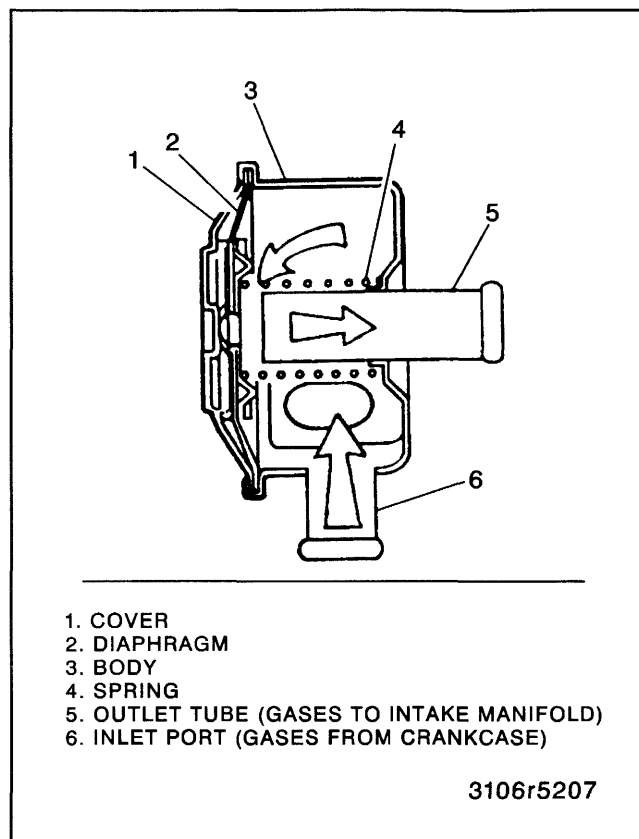


Figure—1 CDR Valve

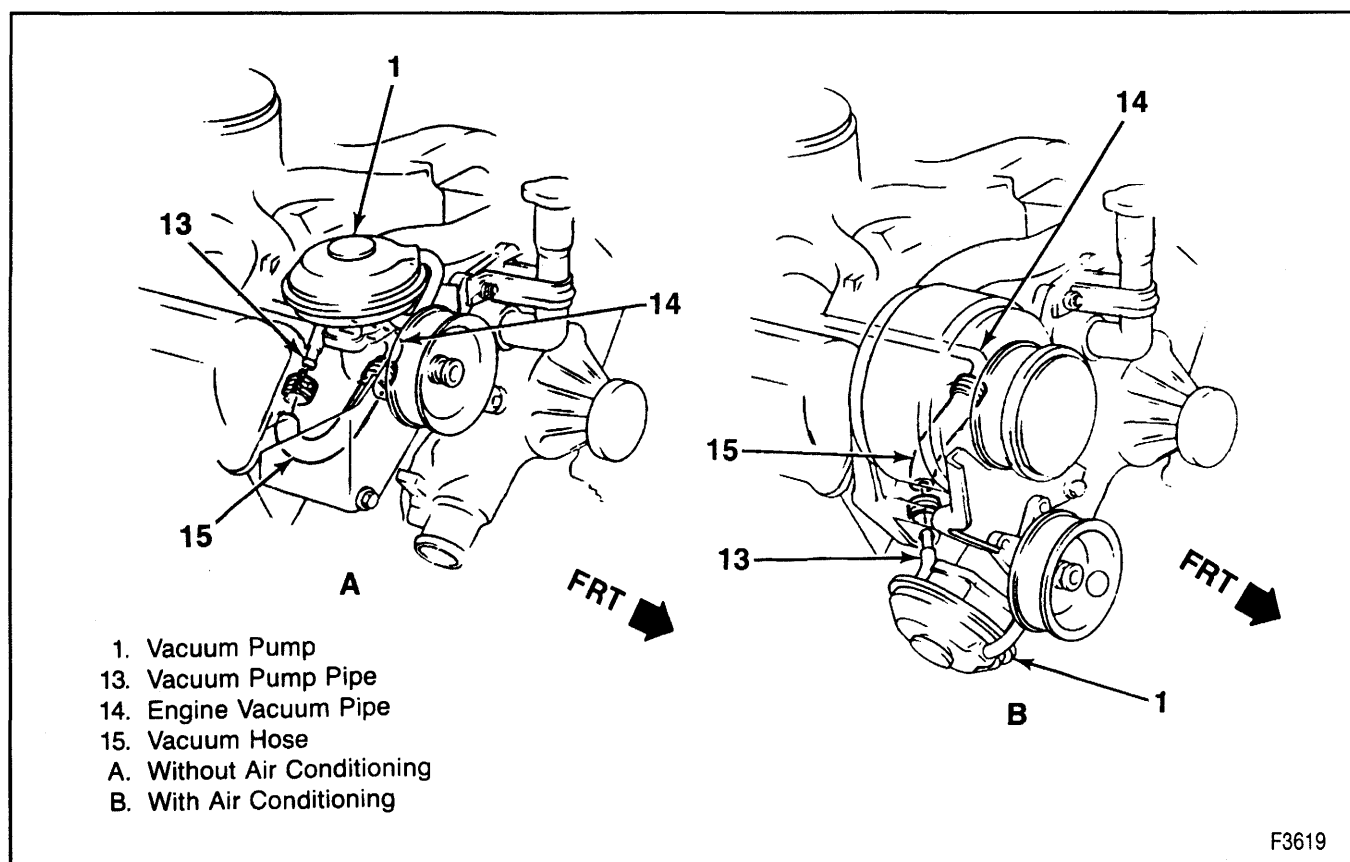
6E2-2 DIESEL EMISSIONS



Figure—2 Crankcase Vapor Flow



Figure—3 CDR Valve Operation



Figure—4 Vacuum Pump and Components

DIAGNOSIS

The purpose of the CDR valve is to maintain 0.75 to 1.0 kPa (3 to 4 hg - inches of mercury) vacuum in the crankcase. Too little vacuum will tend to force oil leaks. Too much vacuum will pull oil into the air crossover.

The CDR valve is checked with a water manometer. The U-tube manometer (figure 5) indicates pressure or vacuum by the difference in the height of two columns of fluid.

CDR VALVE TEST

1. Connect one end of the manometer to the engine oil dipstick hole. The other end of the manometer is vented to atmosphere.
2. Install the air cleaner.
3. Start the engine and observe the manometer reading. It should read one inch of water pressure at idle to approximately 3 to 4 inches of water vacuum at full load. Add the amount that the manometer column travels up, to amount column travels down to obtain total psi/vacuum. An example of a manometer reading is as follows: One-half inch above zero plus one-half inch below zero equals one inch vacuum reading ($1/2'' + 1/2'' = 1''$) (figure 5).

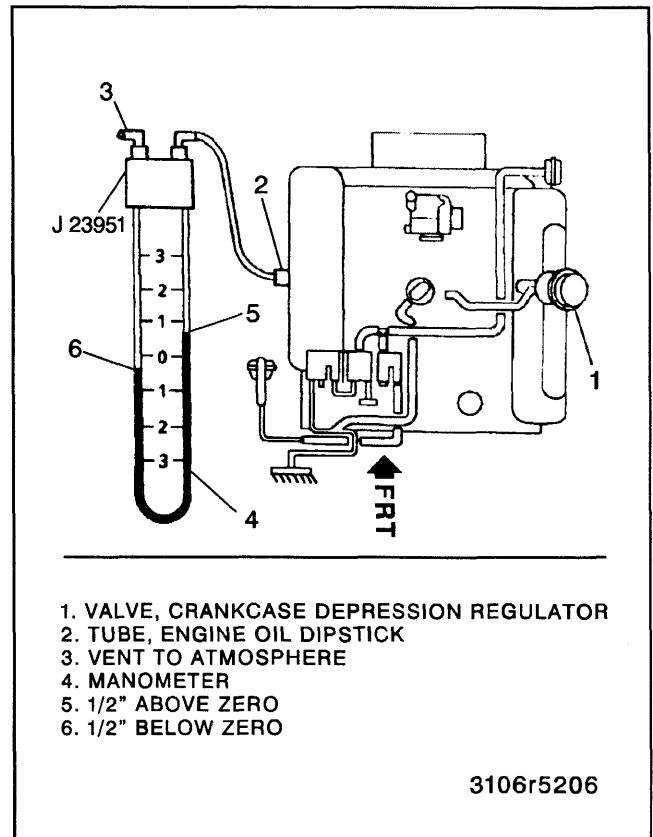


Figure 5—CDR Valve Test

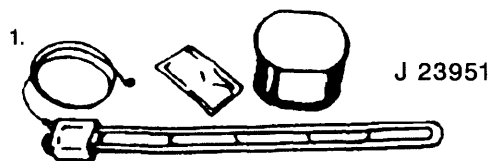
ON-VEHICLE SERVICE

CDR VALVE AND HOSES

NOTICE: Do not allow any solvent to come in contact with the diaphragm of the crankcase depression regulator valve because the diaphragm will fail.

The crankcase depression regulator valve is replaced as an assembly. Replace hoses as required, if inspection indicates cracks or decay. Refer to SECTION 0B for diesel crankcase ventilation system maintenance requirements.

SPECIAL TOOLS



1. MANOMETER

3106r5209

SECTION 6F

EXHAUST SYSTEM

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number for the application. If the correct part number is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Inspection	6F- 3
Removing Exhaust Parts	6F- 3
Installing Exhaust Parts	6F- 3
Close-Couple Catalytic Converter Replacement	6F- 3
Three-Way Catalytic Converter Replacement	6F- 3
Oxidation Catalytic Converter Replacement (Diesel Engines)	6F- 4
Specifications	6F-25
Fastener Tightening Specifications	6F-25

GENERAL DESCRIPTION

Exhaust system designs vary according to the engine designation and intended use of the vehicle.

The exhaust pipe(s), muffler(s), and tailpipe(s) are standard equipment. The exhaust system uses a ball joint coupling to secure the exhaust pipe to the engine manifold. The ball joint allows angular movement for alignment purposes. The other connections use a slip joint coupling design with a clamp and U-bolt.

The exhaust system is suspended by hangers attached to the frame members. These allow some movement of the exhaust system, but should not allow the transfer of noise and vibration into the vehicle.

Heat shields are used to protect the vehicle and the environment from the high temperatures developed from the exhaust system, especially the three-way catalytic converter.

A close-couple catalytic converter operates the same as a three-way catalytic converter to reduce exhaust emissions. The converter and (Y-pipe) assembly

are a one-piece unit. The catalyst in the close-couple converter is not serviceable.

The three-way catalytic converter is an emission control device added to the gasoline engine exhaust system to reduce hydrocarbon, carbon monoxide, and nitrogen oxide pollutants from the exhaust gases. The catalyst in the three-way converter is not serviceable.

NOTICE: The three-way catalytic converter requires the use of unleaded fuel only. Using leaded fuel will damage the catalytic converter and other emission system components.

Several diesel engines use an oxidizing catalytic converter. It's an emission control device added to the exhaust system to reduce smoke (particulates). The oxidizing catalytic converter operates at normal exhaust system temperature as there is no significant temperature increase as a result of oxidation of particulates.

The catalyst in the oxidizing converter is not serviceable.

6F-2 EXHAUST SYSTEM

DIAGNOSIS OF EXHAUST SYSTEM

NOTICE: Replacement of exhaust system parts MUST be OEM standard.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vibrating or Rattling From Exhaust System	Loose and/or misaligned components.	Align, then tighten connections. Check for damaged hanger or mounting brackets and clamps.
Restricted Exhaust System (Gasoline Engines)	1. "Kinked" exhaust tubing. 2. Restriction within the muffler. Refer to "Restricted Exhaust System Check" in the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442. 3. End of tail pipe obstruction. 4. Plugged catalytic converter (may result from serious engine malfunction). Refer to "Restricted Exhaust System Check" in the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442.	1. If possible, repair the damaged condition, otherwise replace the component. 2. If restriction is suspected, remove the muffler and visually check it. Replace muffler if condition is doubtful. 3. Remove the obstruction, or if end is crimped, straighten outlet. 4. Replace the catalytic converter. Correct engine malfunction.
Restricted Exhaust System (Diesel Engines)	1. "Kinked" exhaust tubing. 2. Restriction within the muffler. Refer to "Restricted Exhaust System Check" in the Driveability, Emissions, and Electrical Diagnosis Manual, NATP-9442. 3. End of tail pipe obstruction. 4. Restricted converter. May result from soot deposits due to extended low speed/light load operation or engine malfunction.	1. If possible, repair the damaged condition, otherwise replace the component. 2. If restriction is suspected, remove the muffler and visually check it. Replace muffler if condition is doubtful. 3. Remove the obstruction, or if end is crimped, straighten outlet. 4. Occasional higher load operation should prevent this condition. Repeated full throttle accelerations may correct an existing condition. Correct engine malfunction.
Exhaust Leakage and/or Noise	1. Leakage at exhaust component joints and couplings. 2. Improperly installed or misaligned. 3. Exhaust manifold cracked or broken. 4. Leak between exhaust manifold and cylinder head. 5. Damaged or worn seals or packing. 6. Burned or rusted out exhaust pipe heat tube extension. 7. Burned or rusted out exhaust pipe. 8. Burned or blown out muffler. 9. Broken or loose clamps and/or brackets.	1. Tighten clamps or couplings to specified torque. 2. Align, then tighten connections. 3. Replace the manifold. 4. Tighten the manifold to cylinder head nuts and bolts to specifications. 5. Replace the seals or packing as necessary. 6. Replace the heat tube extensions as required. 7. Replace the exhaust pipe. 8. Replace the muffler assembly. 9. Repair or replace as necessary.

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ON-VEHICLE SERVICE

INSPECTION

Inspect exhaust pipes, catalytic converters (if equipped), mufflers, and tailpipes for cracked joints, broken welds, and corrosion damage that could result in a leaking exhaust system. Inspect the clamps, brackets, and insulators for cracks and stripped or corroded bolt threads.

The exhaust system, including heat shield, must be free of leaks, binding, grounding, and excessive vibration. These conditions are usually caused by damaged or loose flange bolts, heat shields, brackets, or pipes. If any of these conditions exist, check the exhaust system alignment. Align and replace the components as necessary.

REMOVING EXHAUST PARTS

CAUTION: Always wear protective goggles and gloves when removing exhaust parts as falling rust and sharp edges from worn exhaust components could result in serious personal injury.

When removing exhaust components an accumulation of dirt and corrosion can make work difficult. Using a penetrating oil on the threads of U-bolts can assist in the removal of these components.

INSTALLING EXHAUST PARTS

When installing a new exhaust pipe, or muffler, or tailpipe, on any model, check for proper alignment. Rattles and noise vibrations in the exhaust system are usually caused by the misalignment of parts. When aligning the system, leave all bolts and nuts loose until all parts are properly aligned, then tighten, working from the front to the rear.

Damaged exhaust system hangers, hanger brackets, and clamps should be replaced to maintain exhaust system alignment.

Important

- When jacking or lifting the vehicle from the frame side rails, make sure the lift pads do not contact the three-way catalytic converter as damage to the catalytic converter will result.
- Apply sealer (GM P/N 9985020) or equivalent to all slip joint connections.
- When installing the exhaust pipe to the engine manifold, always use new seal and nuts. Clean the engine manifold stud threads with a wire brush before installing the new nuts.

To view exhaust system layouts for C/K vehicles equipped with gasoline engines, refer to figures 1 through 15. Refer to figures 16 through 27 for exhaust system layouts for C/K vehicles with diesel engines.

Refer to figure 15 for the various exhaust system hanger support types.

CLOSE-COUPLE CATALYTIC CONVERTER REPLACEMENT

Remove or Disconnect (Figures 12 and 13)

- Raise the vehicle.
- Support intermediate exhaust pipe.
- 1. Oxygen sensor electrical connection (if equipped).
- 2. Nuts, springs, and flange gasket from exhaust manifold pipe.
- 3. Nuts and washers from rear exhaust pipe flange to intermediate pipe flange.
- 4. Catalytic converter assembly.

Install or Connect (Figures 12 and 13)

NOTICE: For steps 1 and 2, refer to "Notice" on page 6F-1.

- * Position catalytic converter to intermediate pipe.
- 1. Washers and nuts onto rear exhaust pipe flange studs.

Tighten

- Nuts to 43 N.m (32 lbs. ft.)
- 2. Flange gasket, springs, and nuts to exhaust manifold.

Tighten

- Nuts to 29 N.m (22 lbs. ft.).
- 3. Oxygen sensor electrical connection (if equipped).
- Check for clearance and alignment.
- Remove support from intermediate exhaust pipe.
- Lower the vehicle.

THREE-WAY CATALYTIC CONVERTER REPLACEMENT

Remove or Disconnect (Figure 14)

- Raise the vehicle.
- 1. Clamps at the front and rear of the three-way catalytic converter.
- 2. Three-way catalytic converter to front exhaust pipe and three-way catalytic converter to intermediate exhaust pipe.
- 3. Three-way catalytic converter.

Install or Connect

1. Three-way catalytic converter into the exhaust pipe.

NOTICE: Refer to "Notice" on page 6F-1.

2. New U-bolts and clamps at the front and rear of the three-way catalytic converter.

6F-4 EXHAUST SYSTEM



Tighten

- Bolts to specifications, refer to "Specifications."
- Check for clearance and alignment.
- Lower the vehicle.

OXIDATION CATALYTIC CONVERTER REPLACEMENT



Remove or Disconnect (Figure 16)

- Raise the vehicle.
1. Fasteners at the front and rear of the oxidation catalytic converter.
 2. Oxidation catalytic converter from front exhaust pipe and to intermediate exhaust pipe.
 3. Oxidation catalytic converter.



Install or Connect

1. New oxidation catalytic converter into the exhaust pipe.

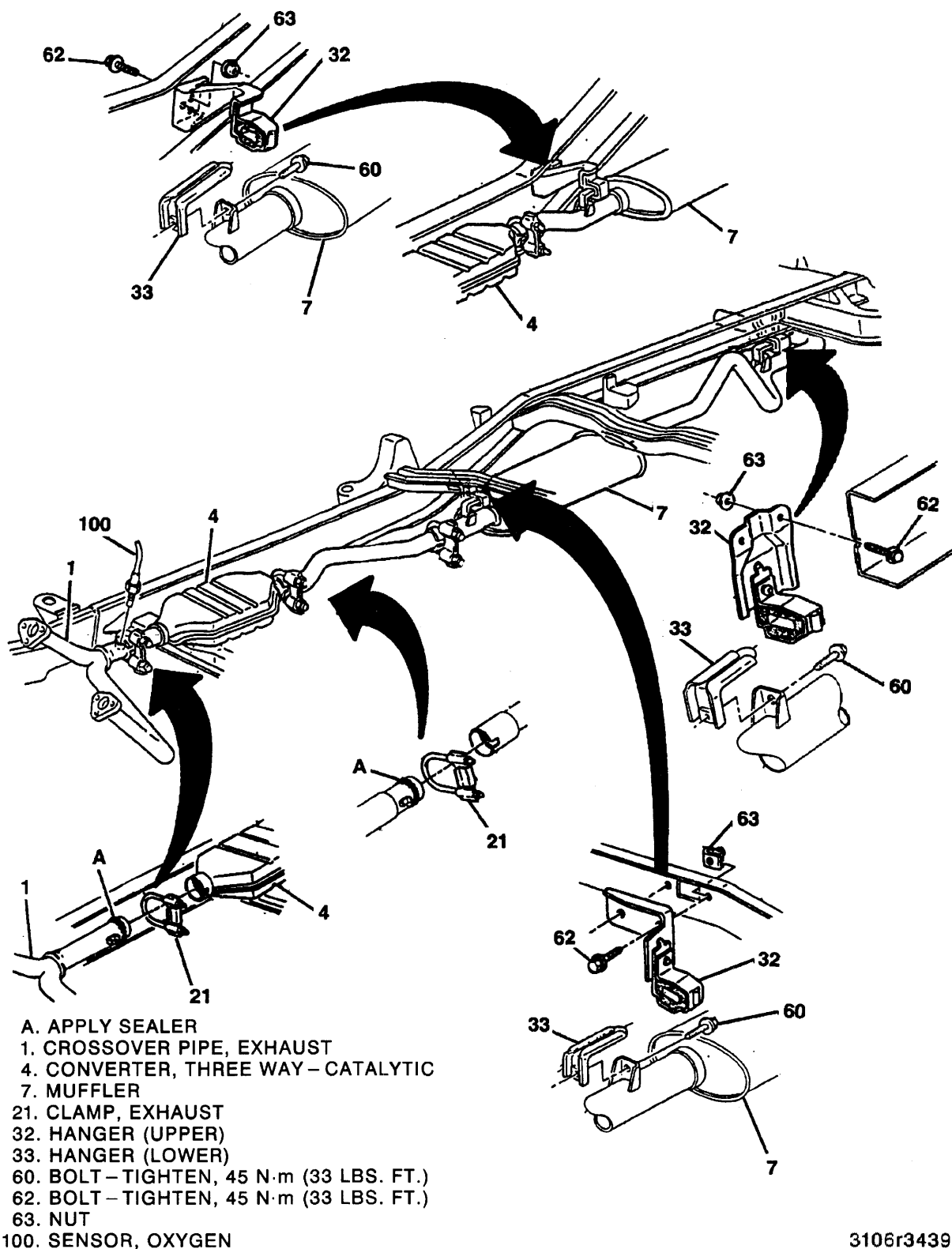
NOTICE: Refer to "Notice" on page 6F-1.

2. New seals and fasteners at the front and rear of the converter.



Tighten

- Nuts to 40 N.m (30 lbs. ft).
- Check for clearance and alignment.
- Lower the vehicle.



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Figure 1—Exhaust System - 4.3L V6 and 5.0L V8, CK1, and CK2 with 7200 LBS. GVW, Regular Cab Models

6F-6 EXHAUST SYSTEM

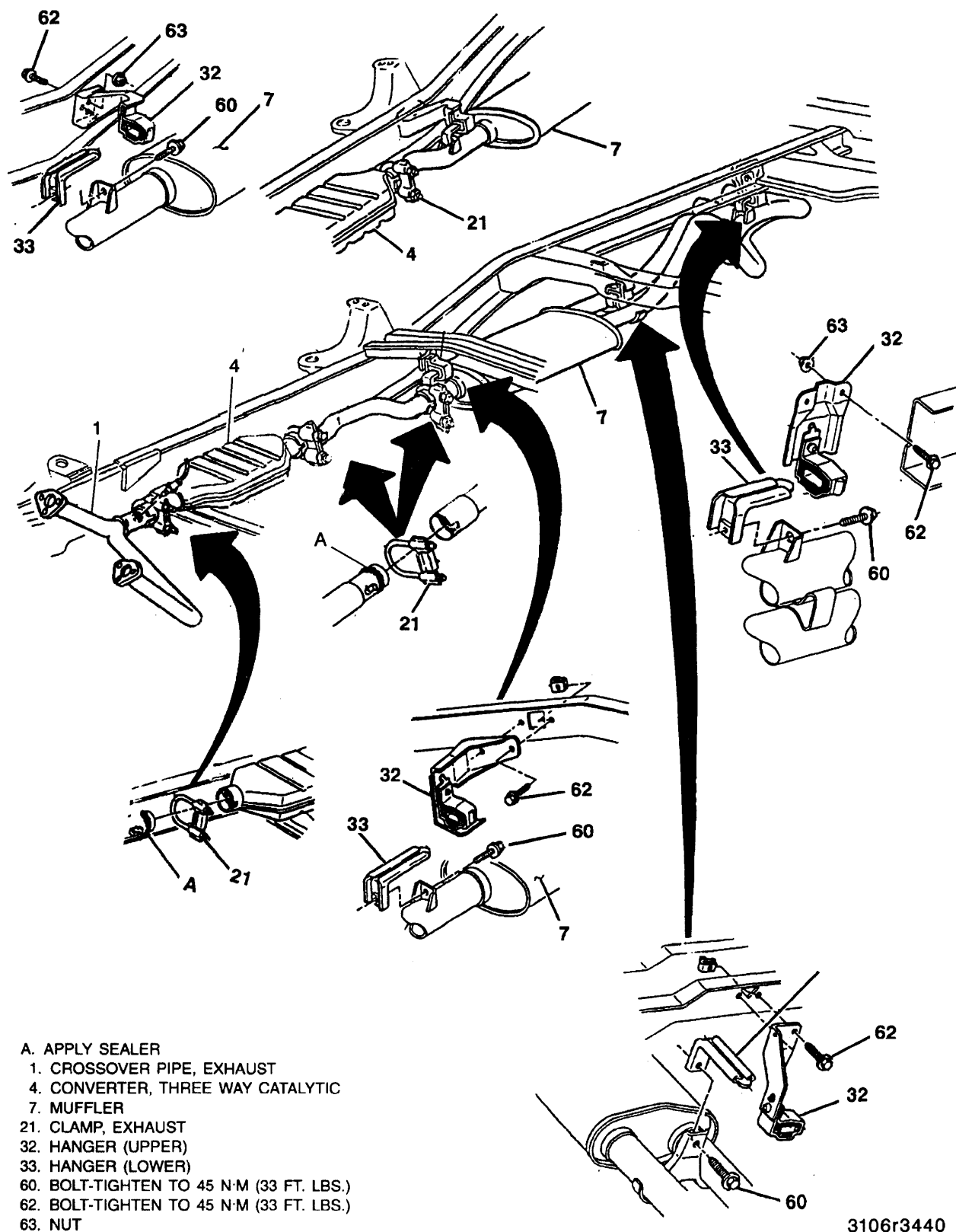
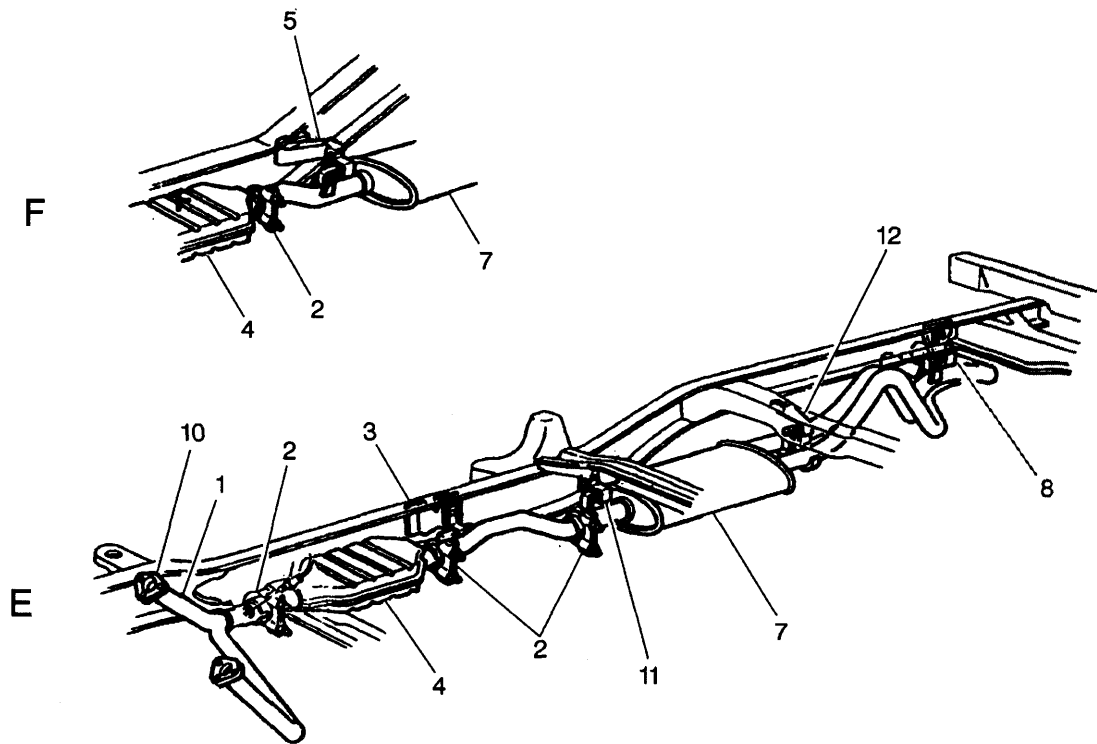


Figure 2—Exhaust System - 5.7L V8, CK1, and CK2 with 7200 LBS. GVW, Regular Cab Models



E. CD 109, 209 (53)(03), 5.7L V8
 F. CK 107 (03)
 1. EXHAUST CROSSOVER PIPE
 2. CLAMP - METHOD B
 3. SUPPORT - TYPE AE
 4. CATALYTIC CONVERTER

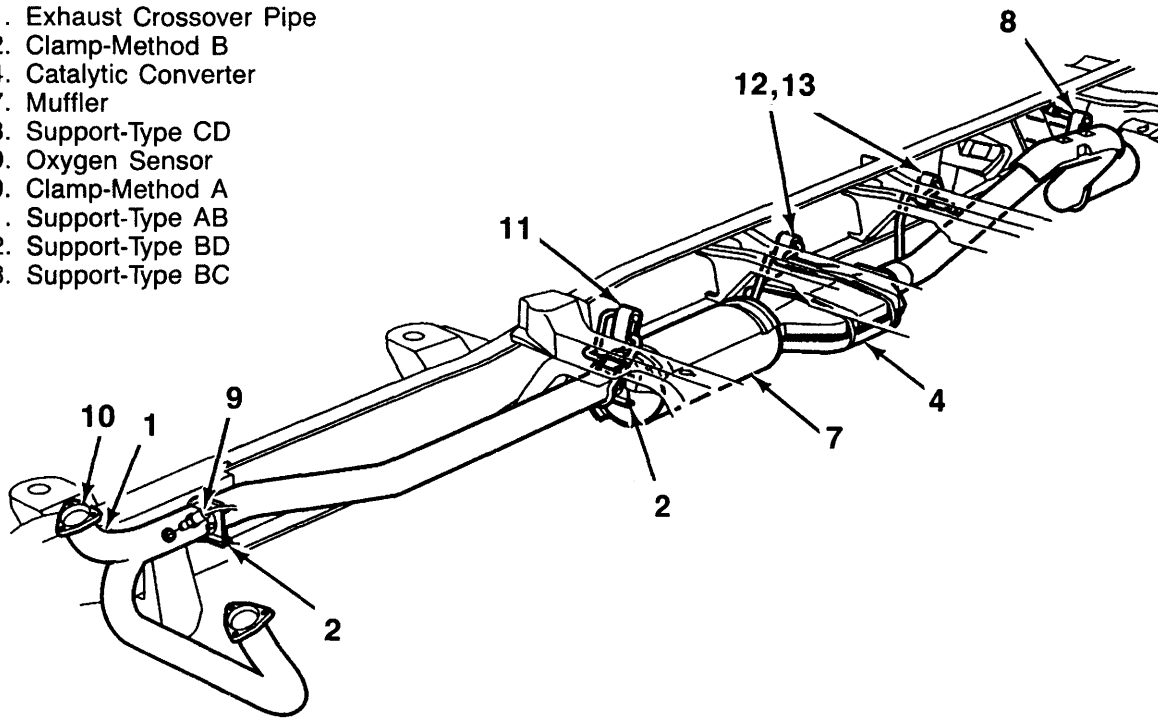
5. SUPPORT - TYPE AD
 7. MUFFLER
 8. SUPPORT - TYPE CD
 10. CLAMP - METHOD A
 11. SUPPORT - TYPE AB
 12. SUPPORT - TYPE BD

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Figure 3—Exhaust System—5.7L V8 Extended Cab, 8' Box, 6 1/2' Box

6F-8 EXHAUST SYSTEM

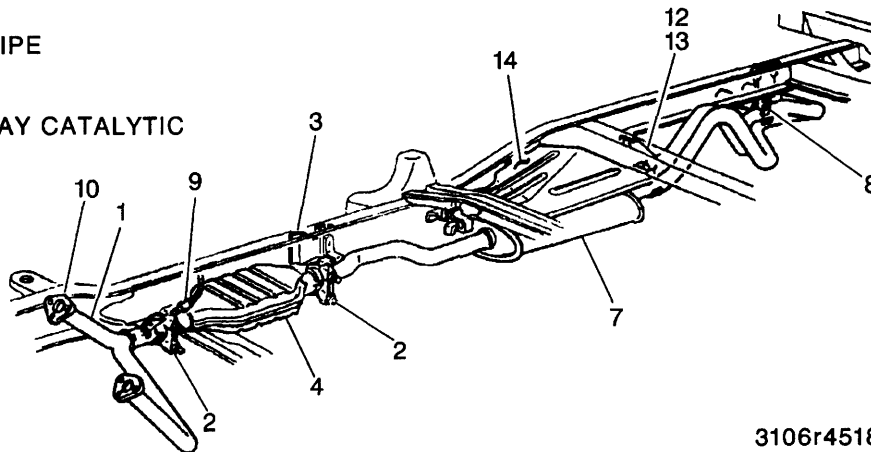
1. Exhaust Crossover Pipe
2. Clamp-Method B
4. Catalytic Converter
7. Muffler
8. Support-Type CD
9. Oxygen Sensor
10. Clamp-Method A
11. Support-Type AB
12. Support-Type BD
13. Support-Type BC



F9773

Figure 4—Exhaust System - 7.4L V8, CK3 (Except Crewcab)

- H. CK309 (53)(03), 5.7L V8
1. EXHAUST CROSSOVER PIPE
 2. CLAMP - METHOD B
 3. SUPPORT - TYPE AE
 4. CONVERTER, THREE - WAY CATALYTIC
 7. MUFFLER
 8. SUPPORT - TYPE CD
 9. OXYGEN SENSOR
 10. CLAMP - METHOD A
 12. SUPPORT - TYPE BD
 13. SUPPORT - TYPE BC
 14. HEAT SHIELD - TYPE U



3106r4518

Figure 5—Exhaust System - 5.7L V8, CK3 (Except Crewcab)

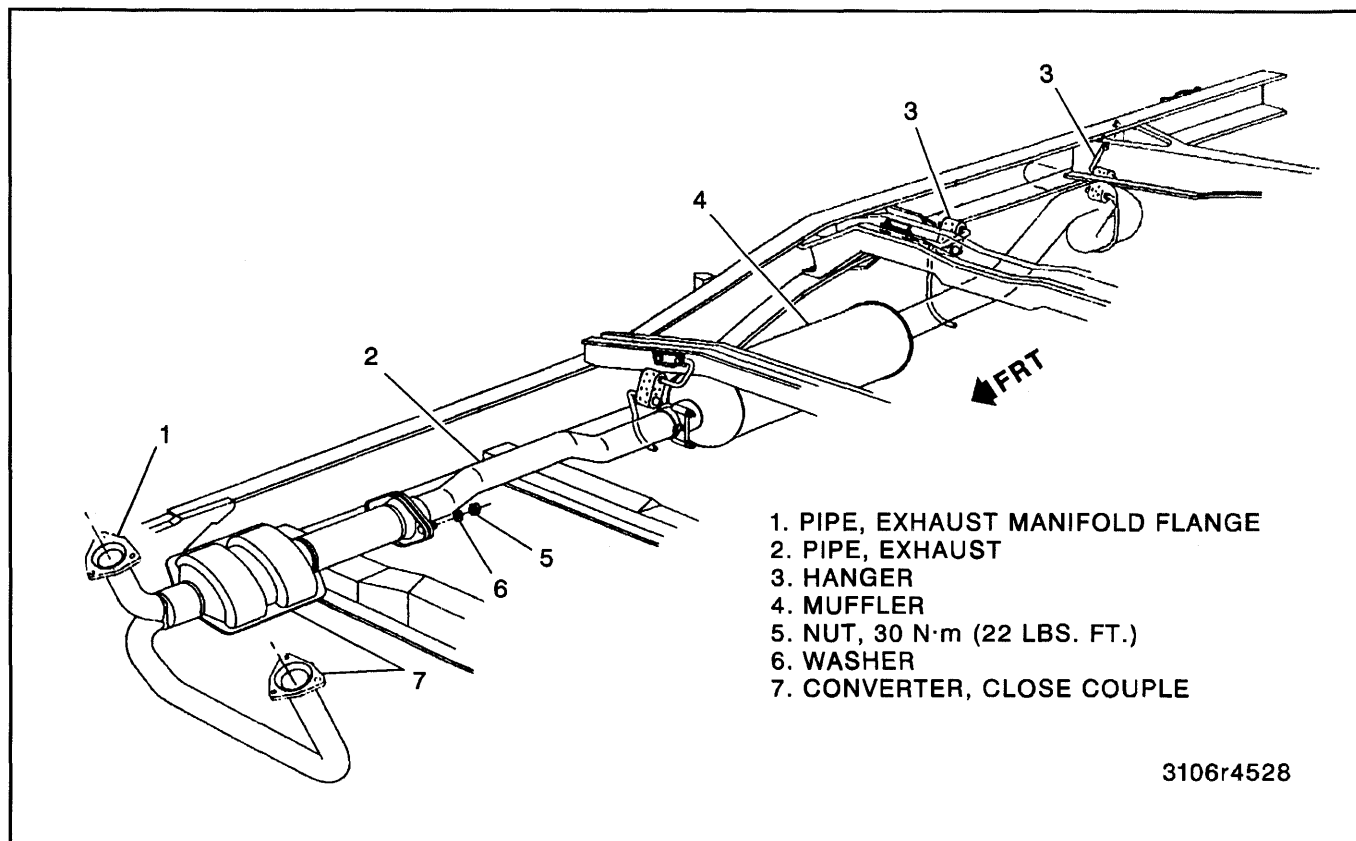


Figure 6—Exhaust System - CK1 and CK2 with Close Couple Catalytic Converter

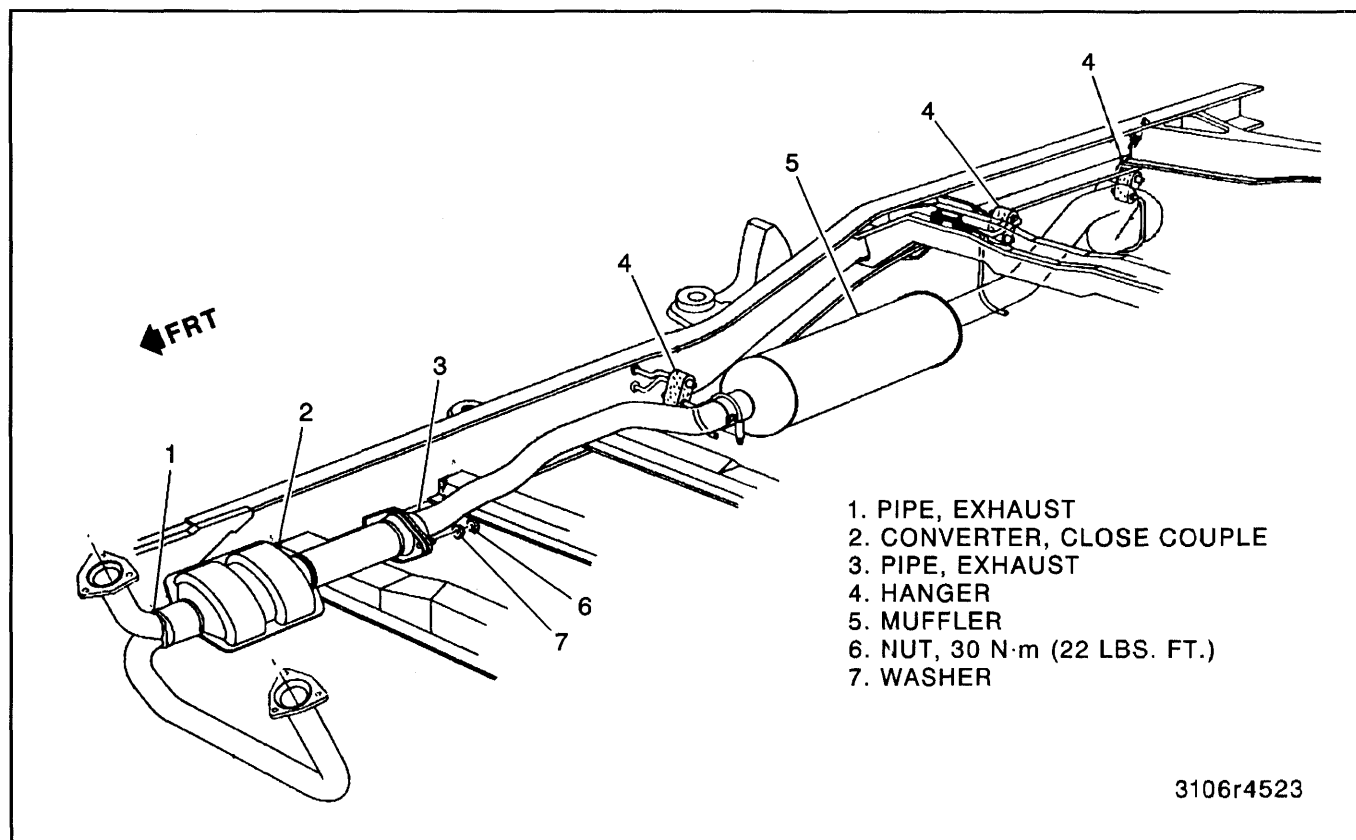
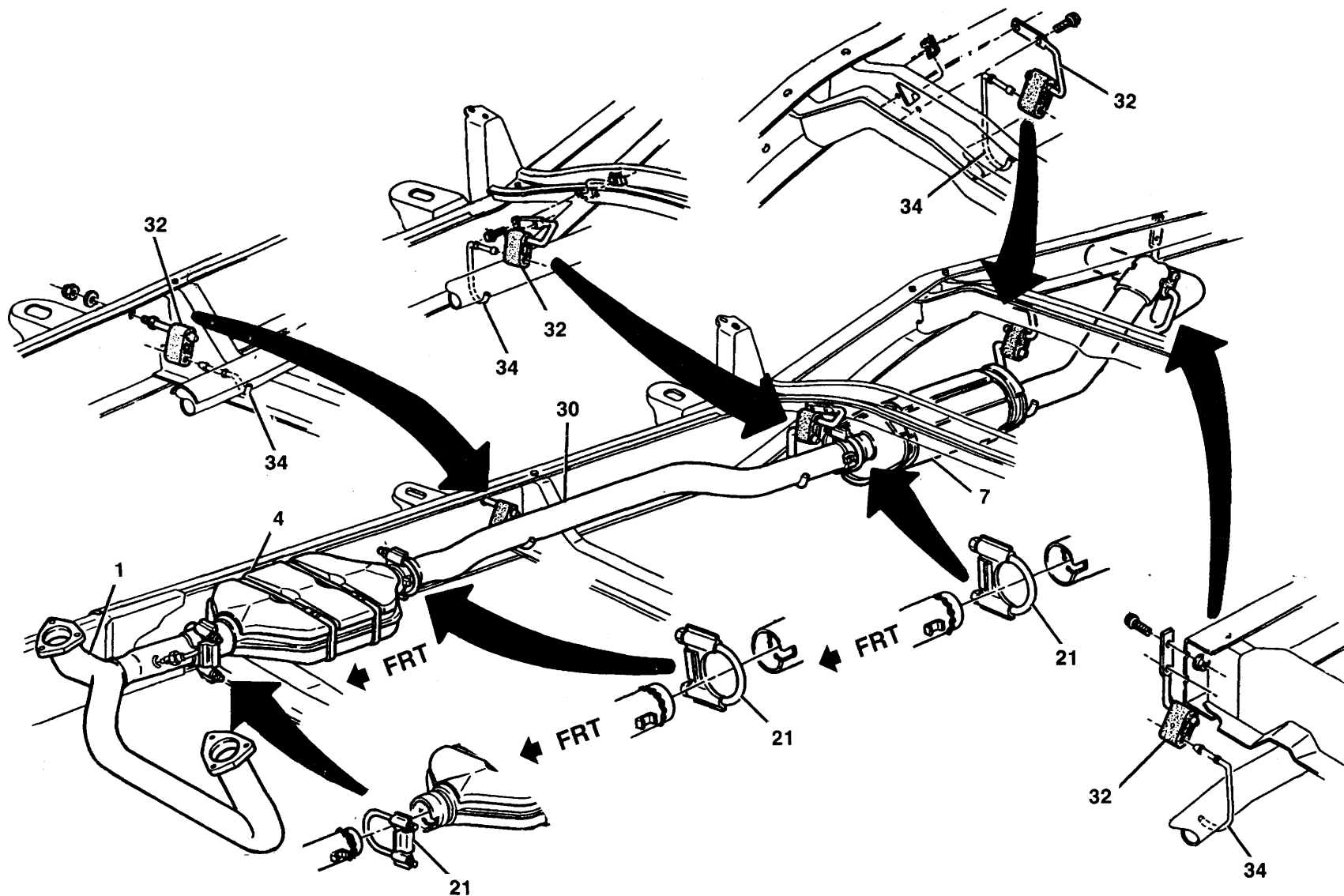
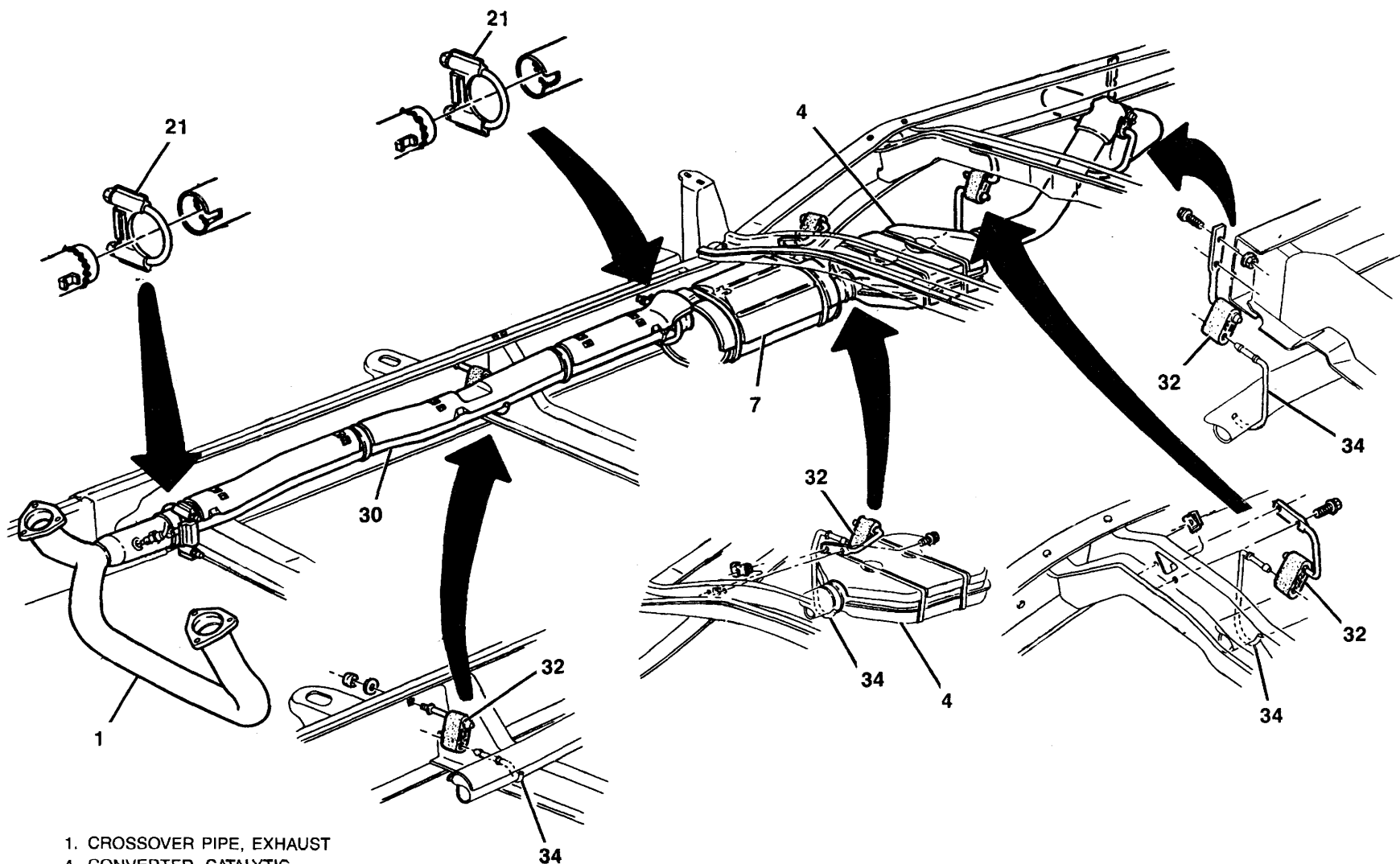


Figure 7—Exhaust System - CK1 and CK2 Pickup and Extended Cab Models



- | | |
|----------------------------|-------------------------|
| 1. CROSSOVER PIPE, EXHAUST | 30. PIPE, EXHAUST |
| 4. CONVERTER, CATALYTIC | 32. HANGER, EXHAUST |
| 7. MUFFLER | 34. ROD, EXHAUST HANGER |
| 21. CLAMP, EXHAUST | |

Figure 8—Exhaust System - Crewcab with 5.7L



- 1. CROSSOVER PIPE, EXHAUST
- 4. CONVERTER, CATALYTIC
- 7. MUFFLER
- 21. CLAMP, EXHAUST
- 30. PIPE, EXHAUST
- 32. HANGER, EXHAUST
- 34. ROD, EXHAUST HANGER

Figure 9—Exhaust System - CK, Crewcab with 7.4L

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6F-12 EXHAUST SYSTEM

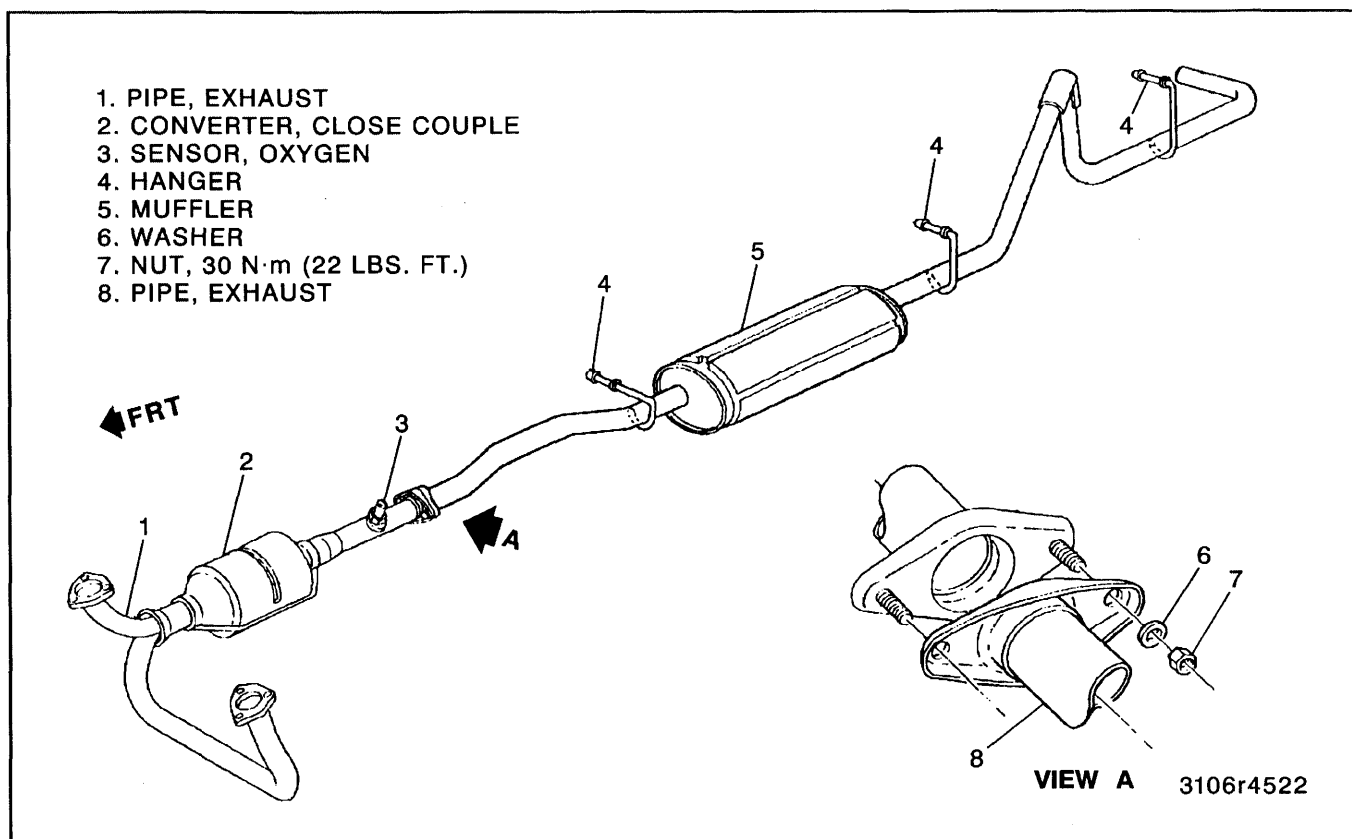


Figure 10—Exhaust System - CK and Suburban with 5.7L

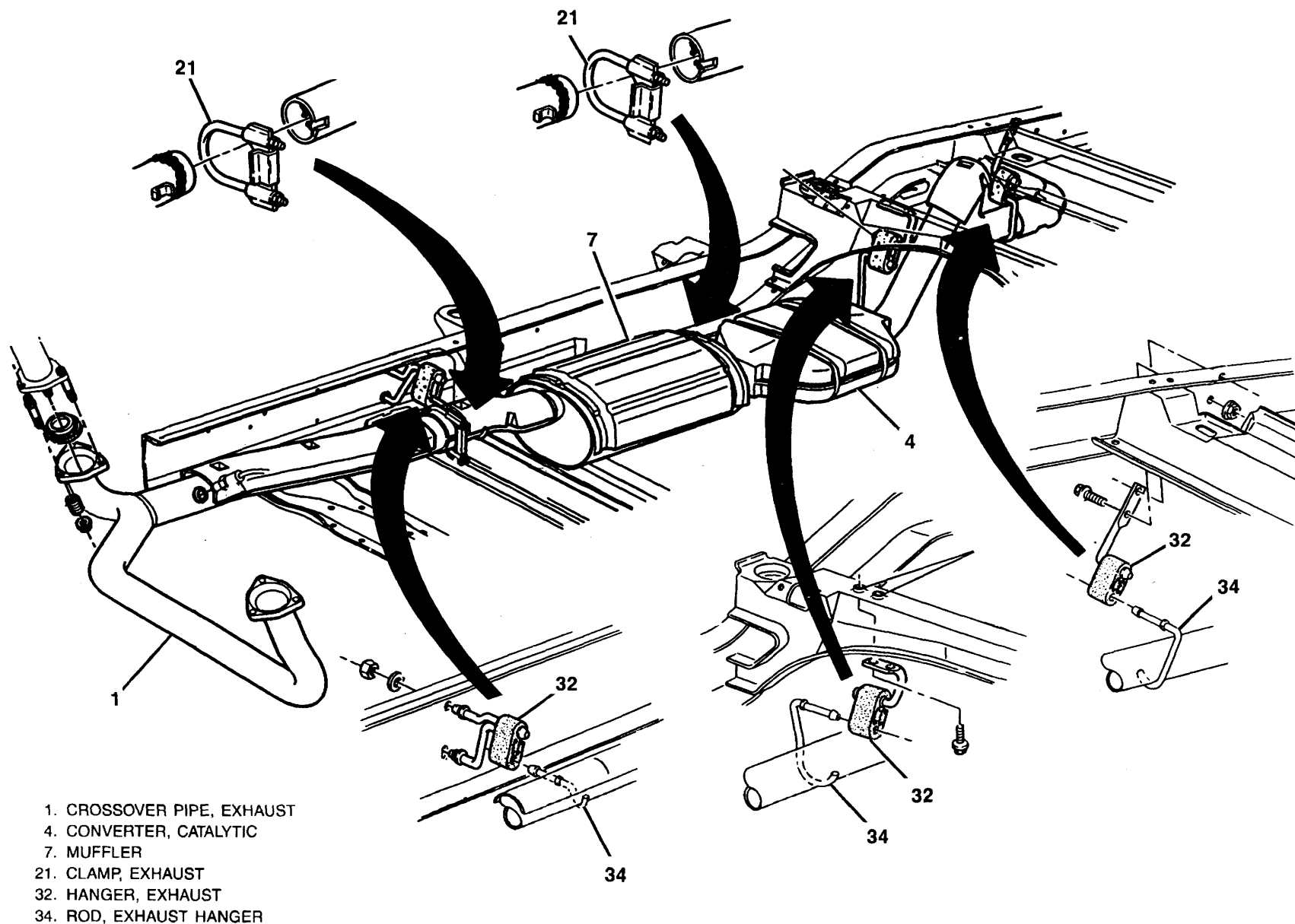


Figure 11—Exhaust System - CK and Suburban with 7.4L

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6F-14 EXHAUST SYSTEM

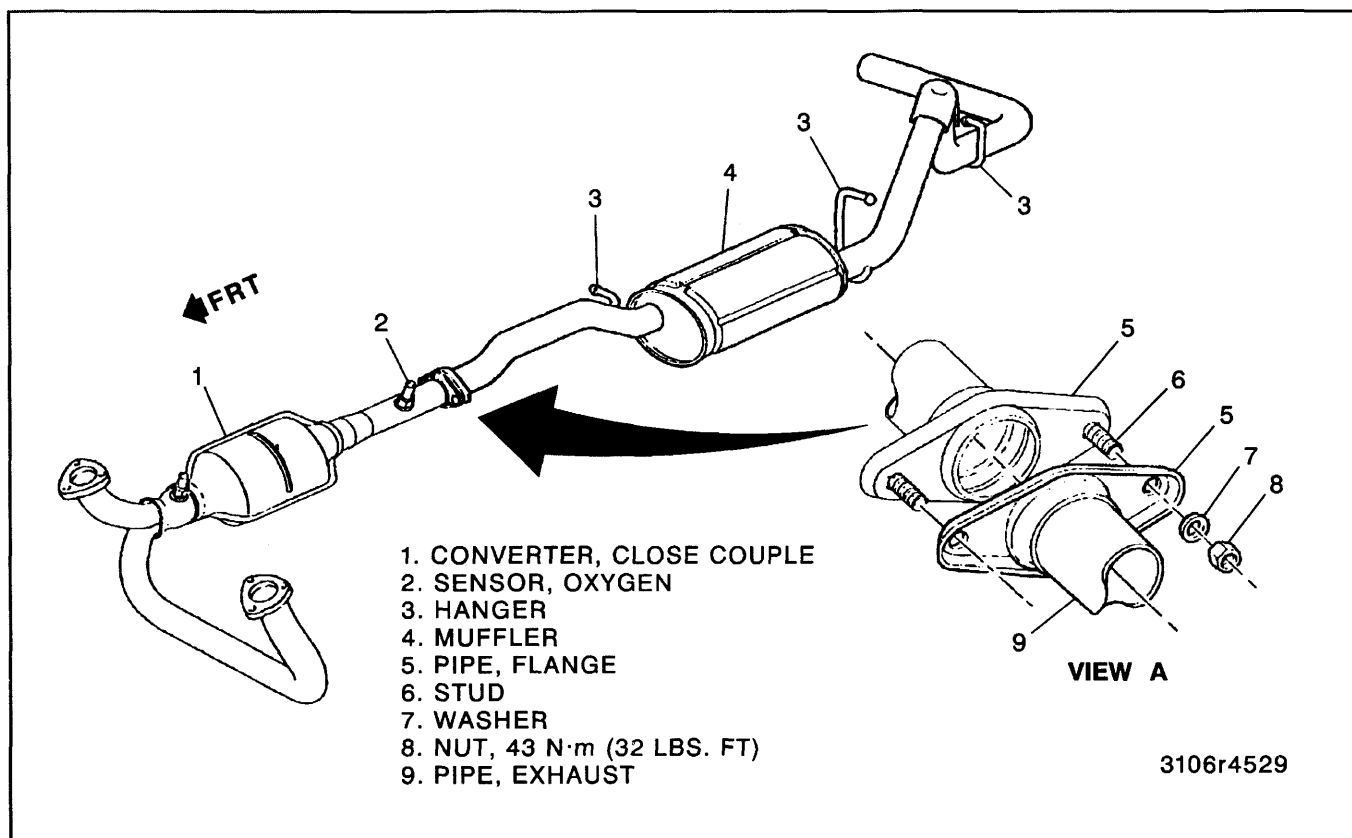


Figure 12—Exhaust System - K, Utility with 5.7L

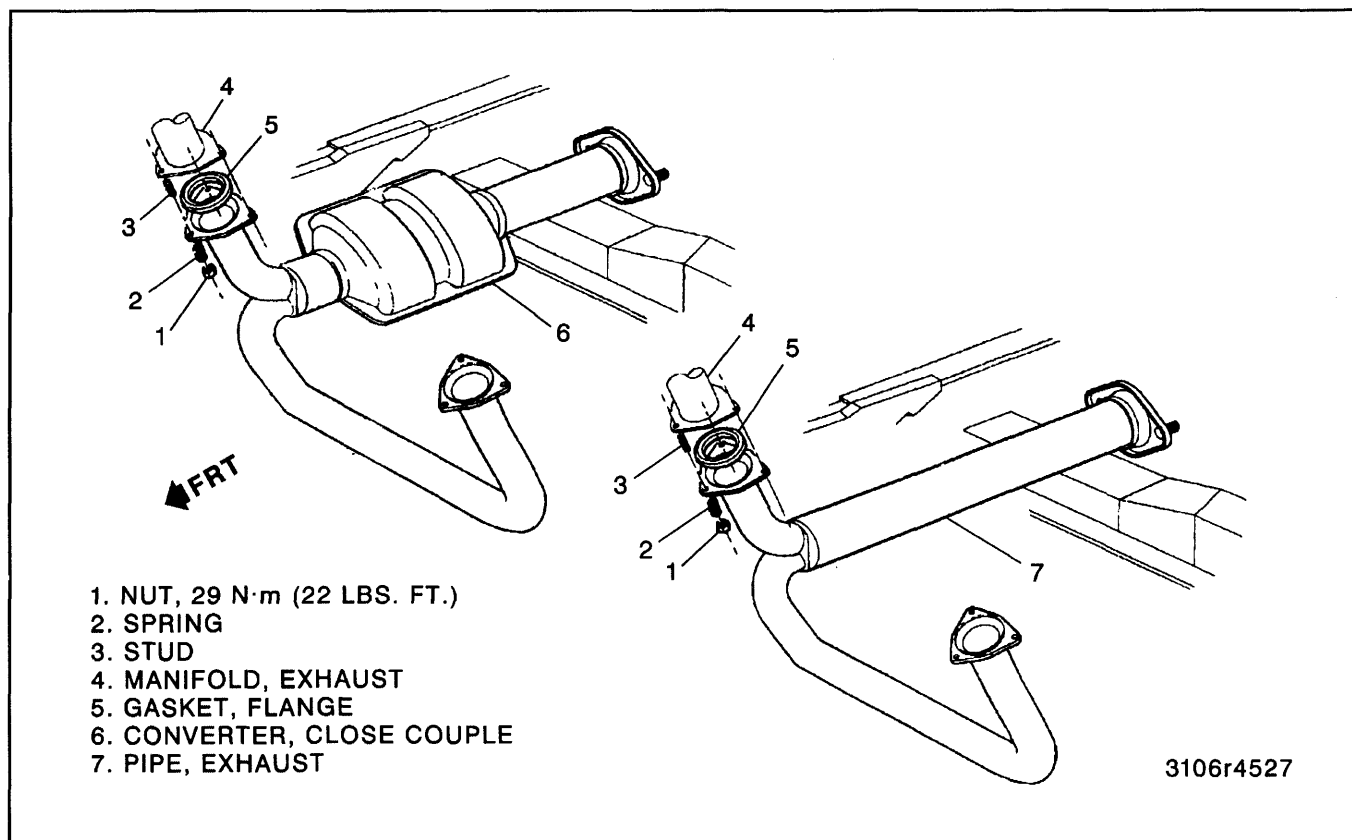


Figure 13—Close Couple Catalytic Converter and Components

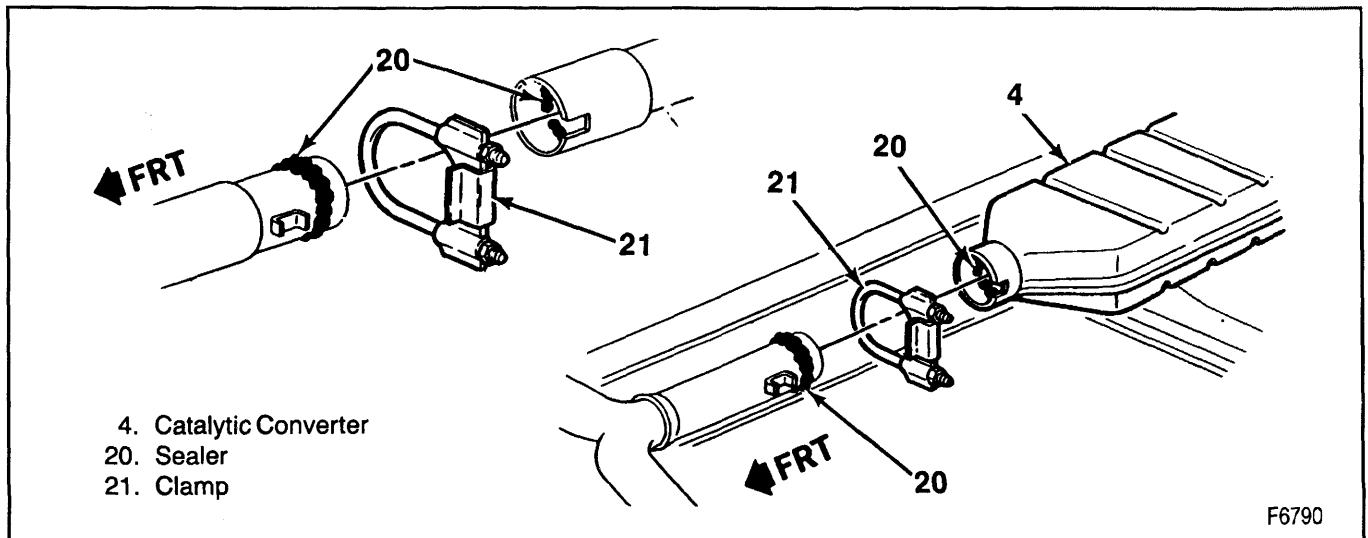
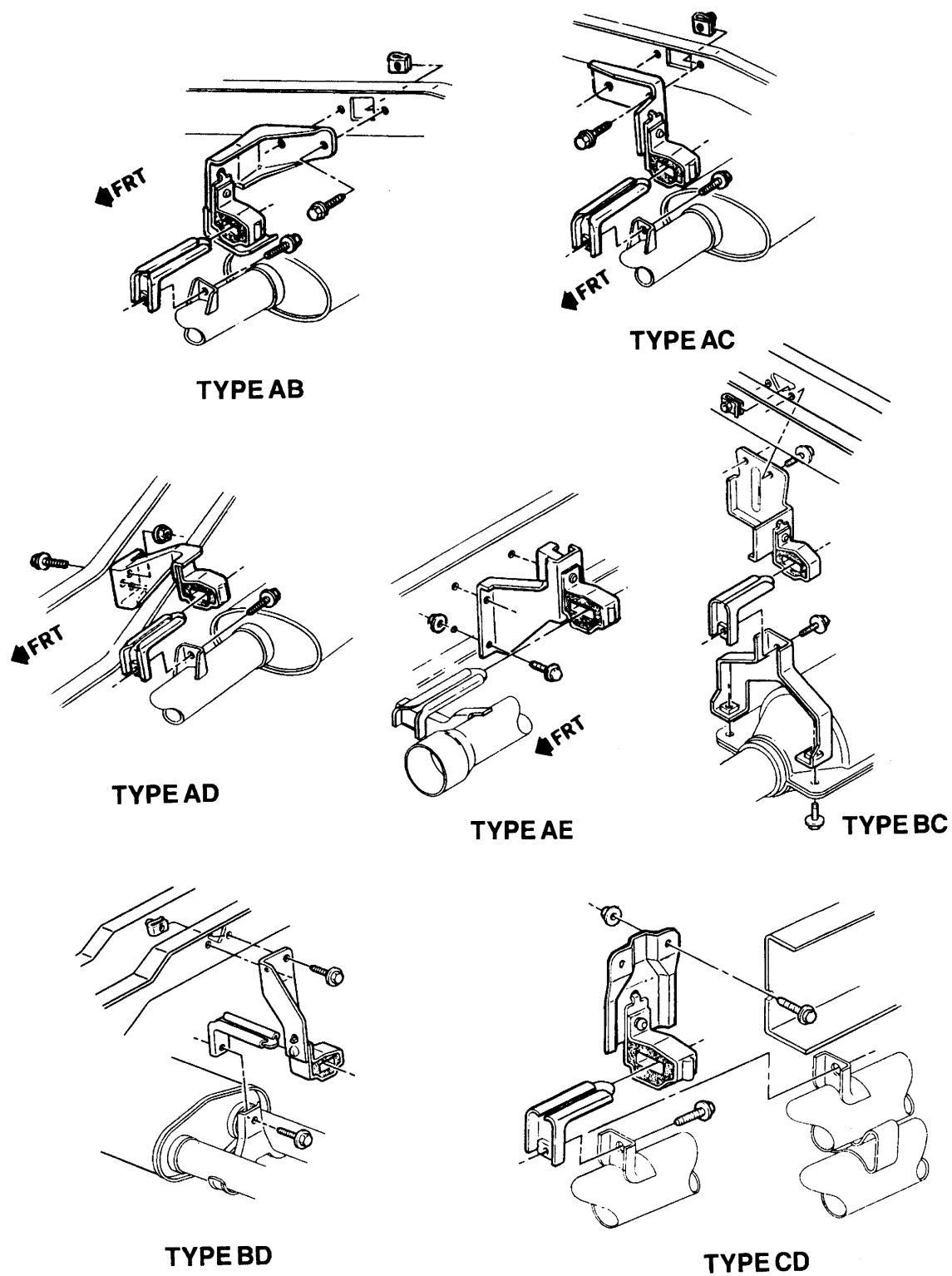


Figure 14—Three Way Catalytic Converter and Components



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Figure 15—Support Types, CK Pickup (Except Crewcab)

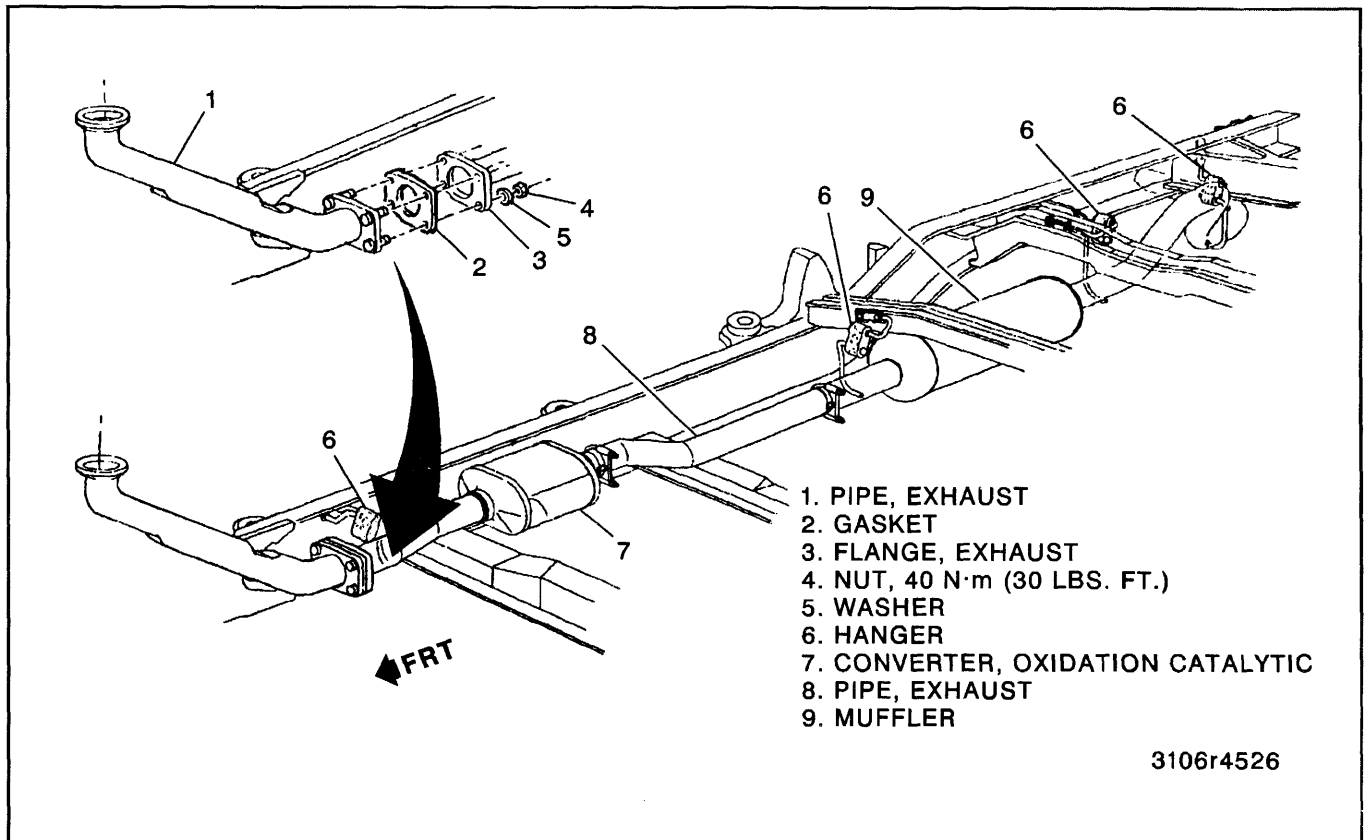


Figure 16—Exhaust System - 6.5L Light Duty CK 1,2, and 3 (L56, VIN S and L65, VIN F)

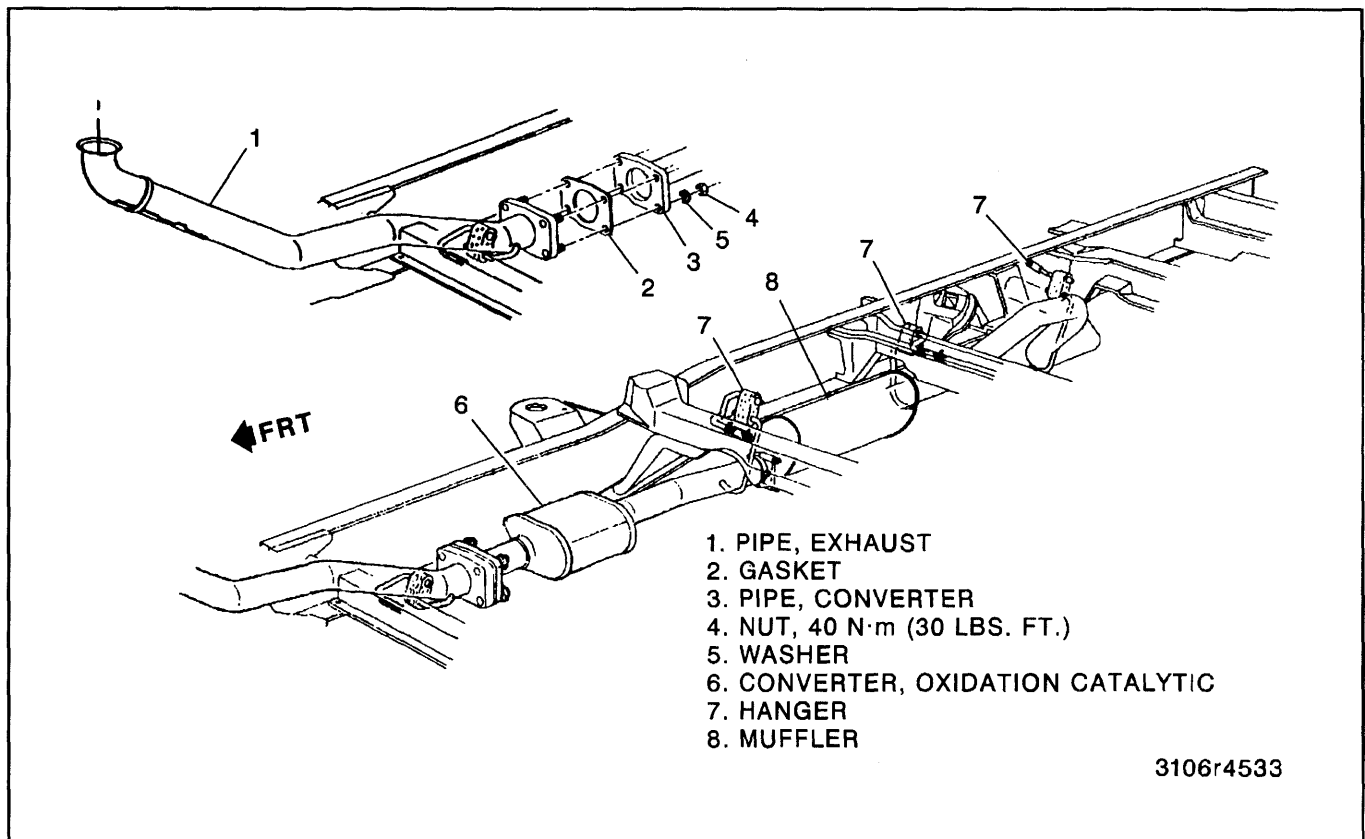


Figure 17—Exhaust System - 6.5L CK with 15000 LBS Regular Cab Models

6F-18 EXHAUST SYSTEM

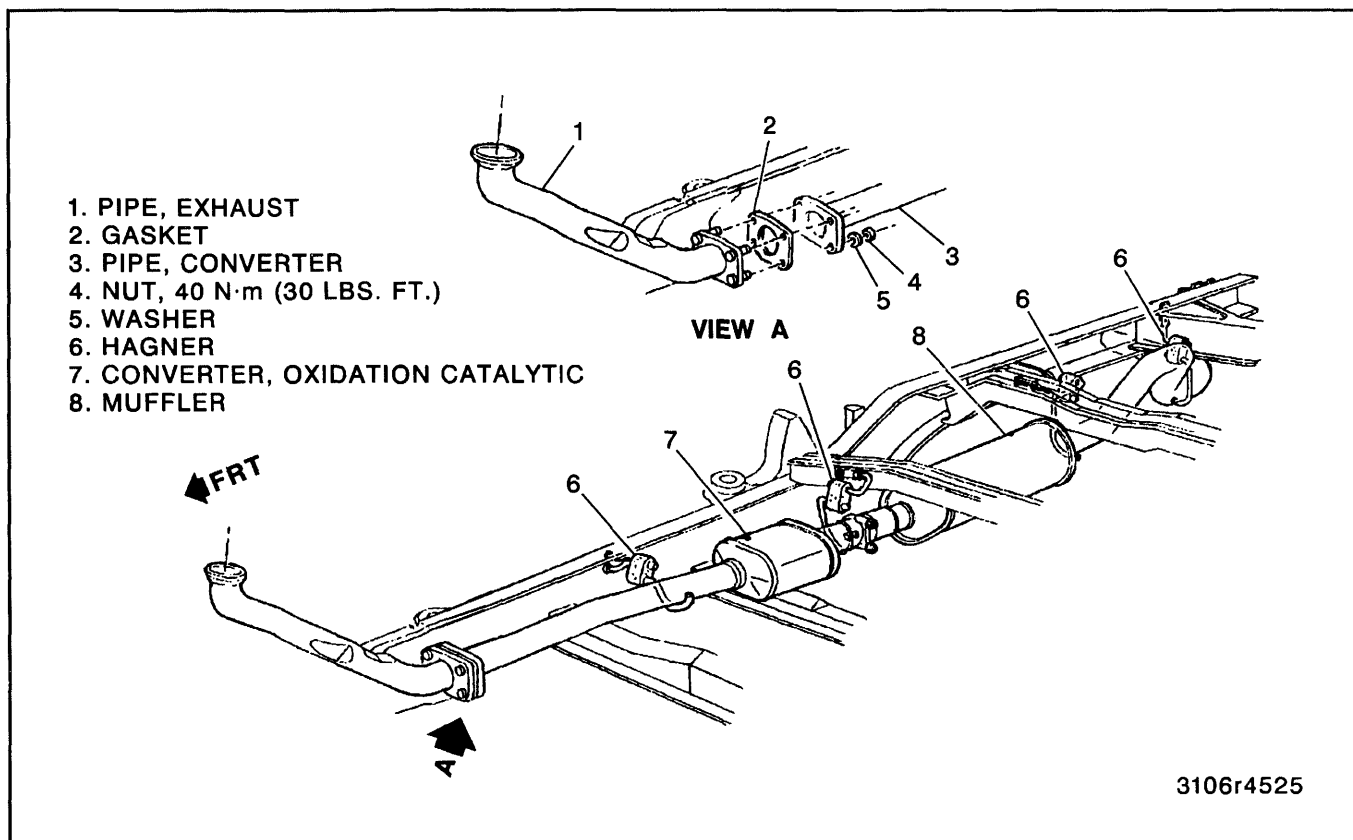


Figure 18—Exhaust System - 6.5L Heavy Duty, CK2 and CK3 Models

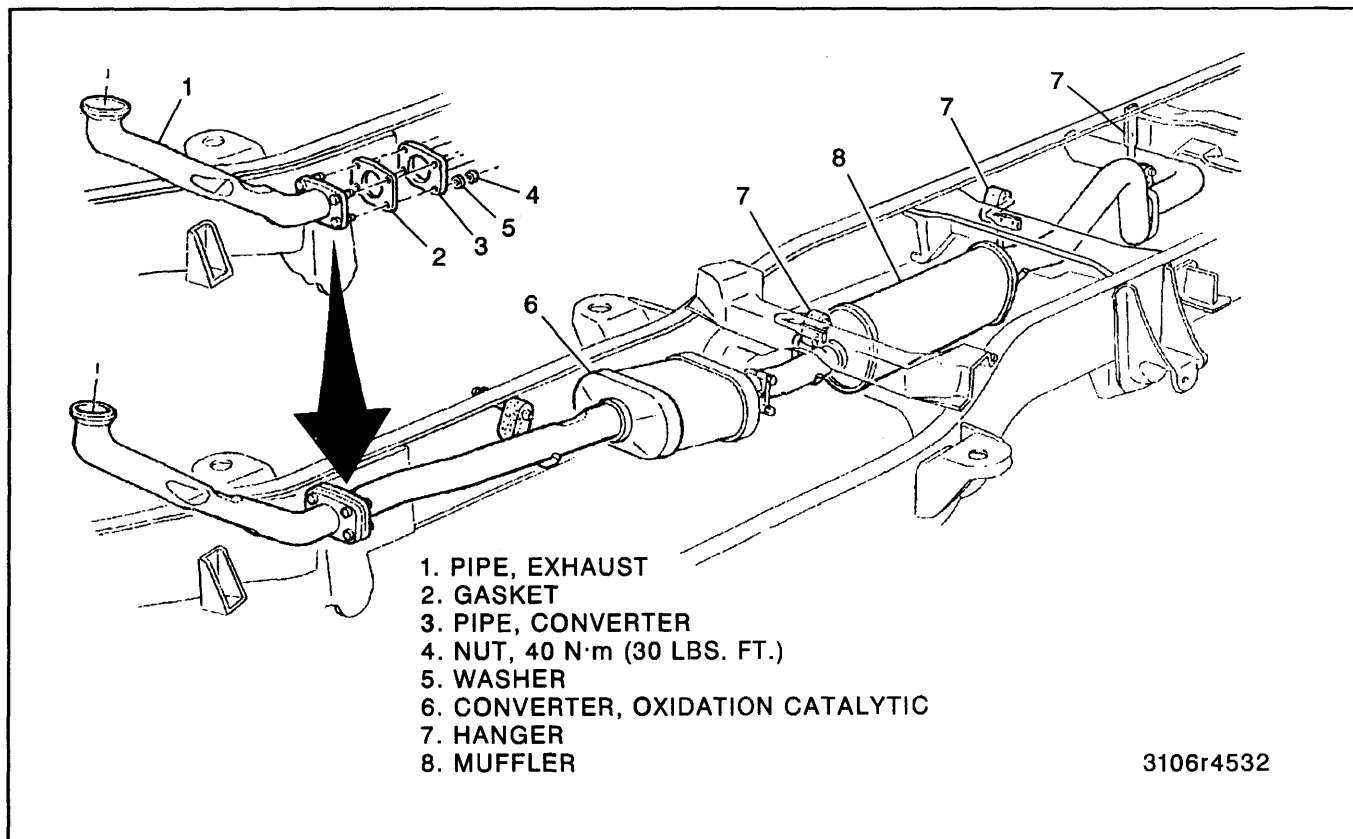


Figure 19—Exhaust System - 6.5L CK3 Regular Cab (L65, VIN F)

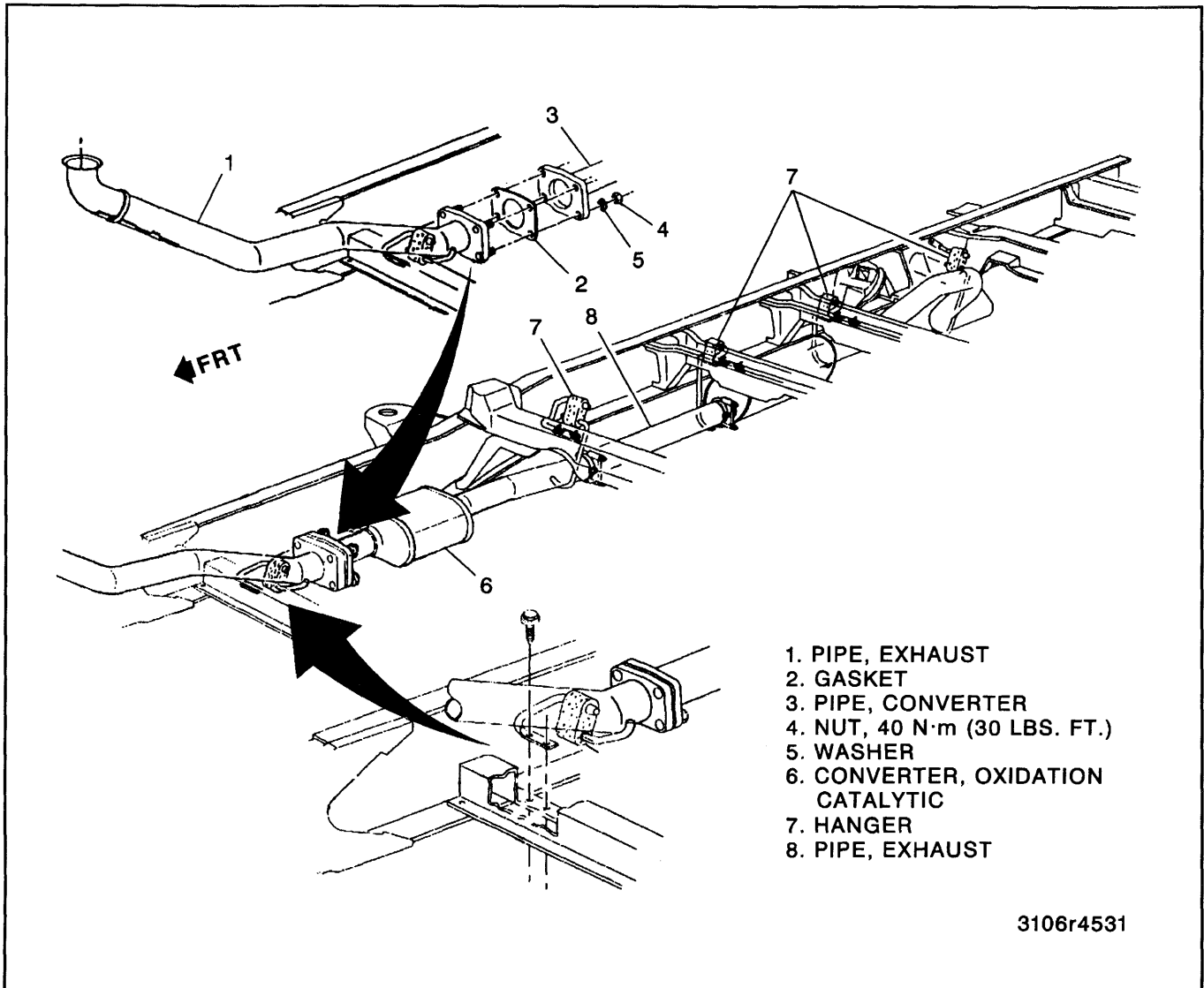


Figure 20—Exhaust System - 6.5L Sierra 3500 HD Chassis Cab (L65, VIN F)

6F-20 EXHAUST SYSTEM

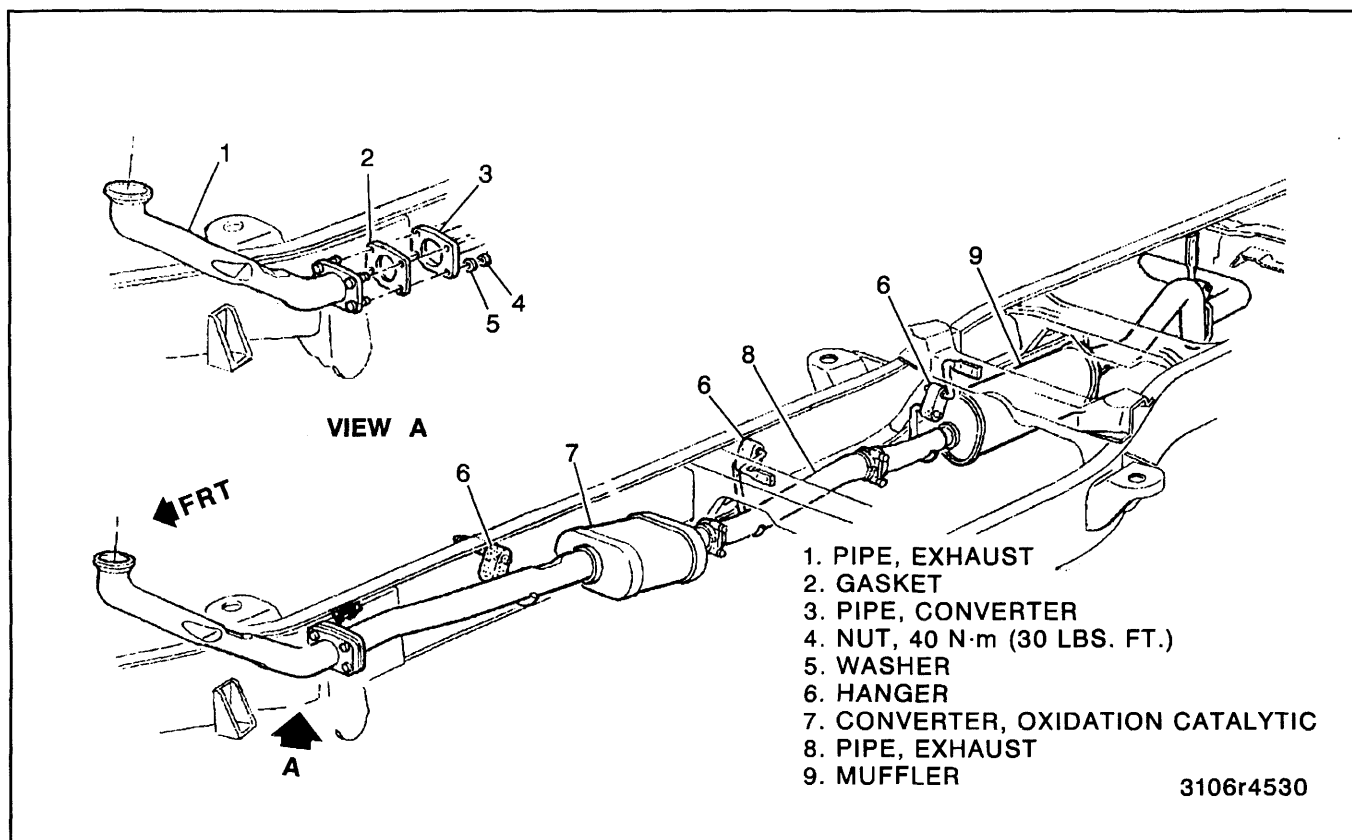


Figure 21—Exhaust System - 6.5L 3500 HD Chassis Cab (L65, VIN F)

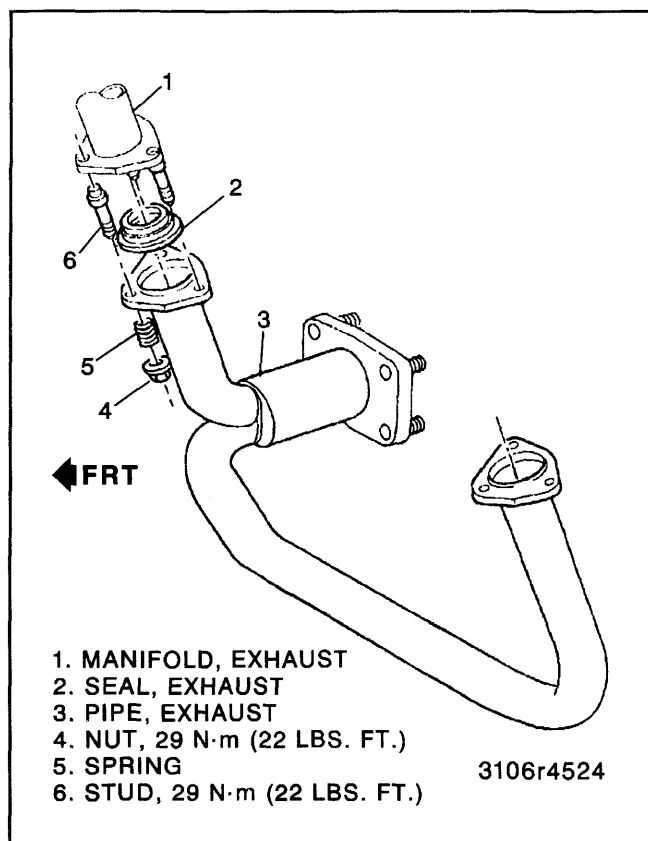


Figure 22—Exhaust Crossover Pipe 6.5L (L49, VIN P)

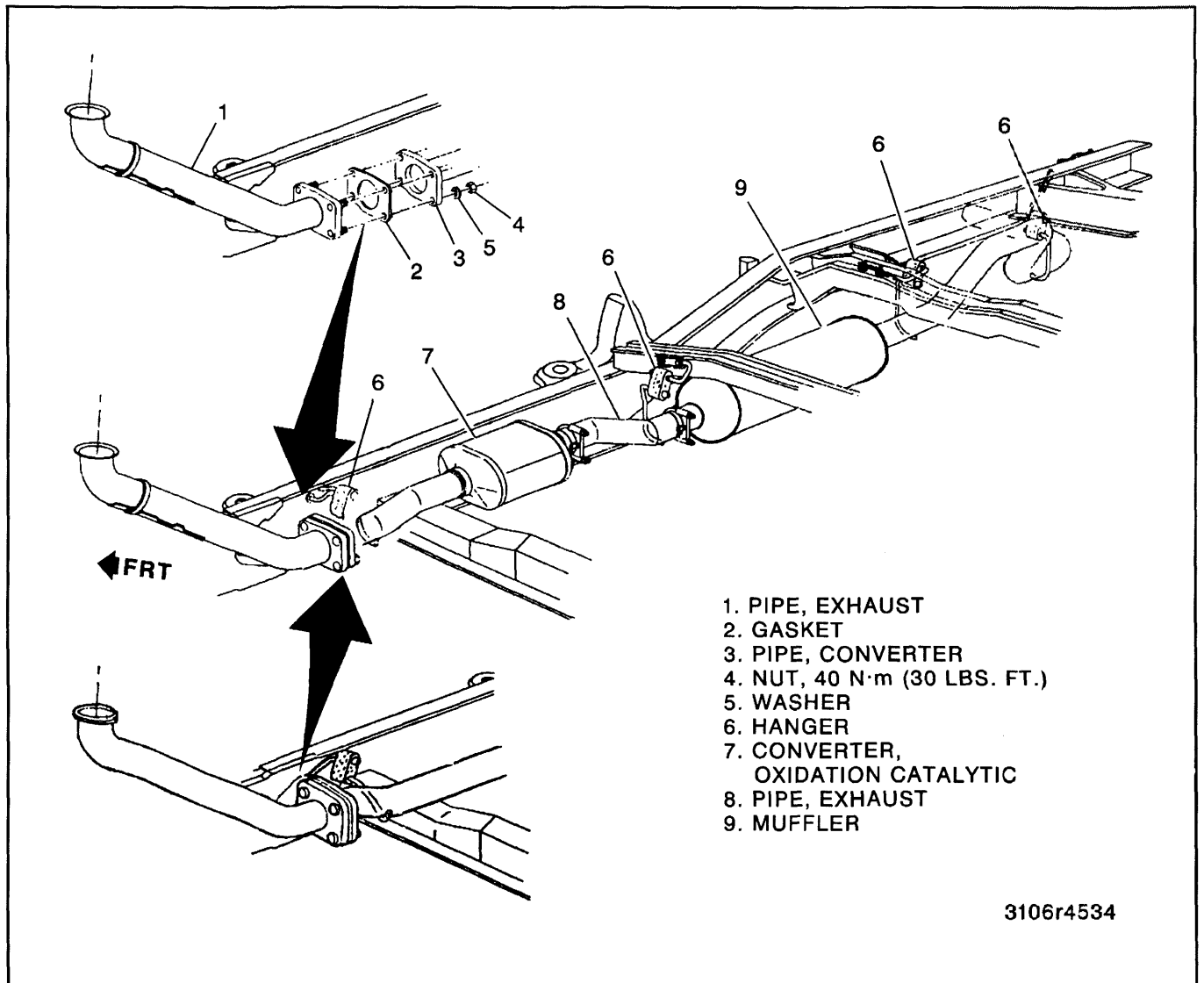


Figure 23—Exhaust System - CK 3/4 and 1 Ton, Regular Cab with 6.5L (L56, VIN S)

6F-22 EXHAUST SYSTEM

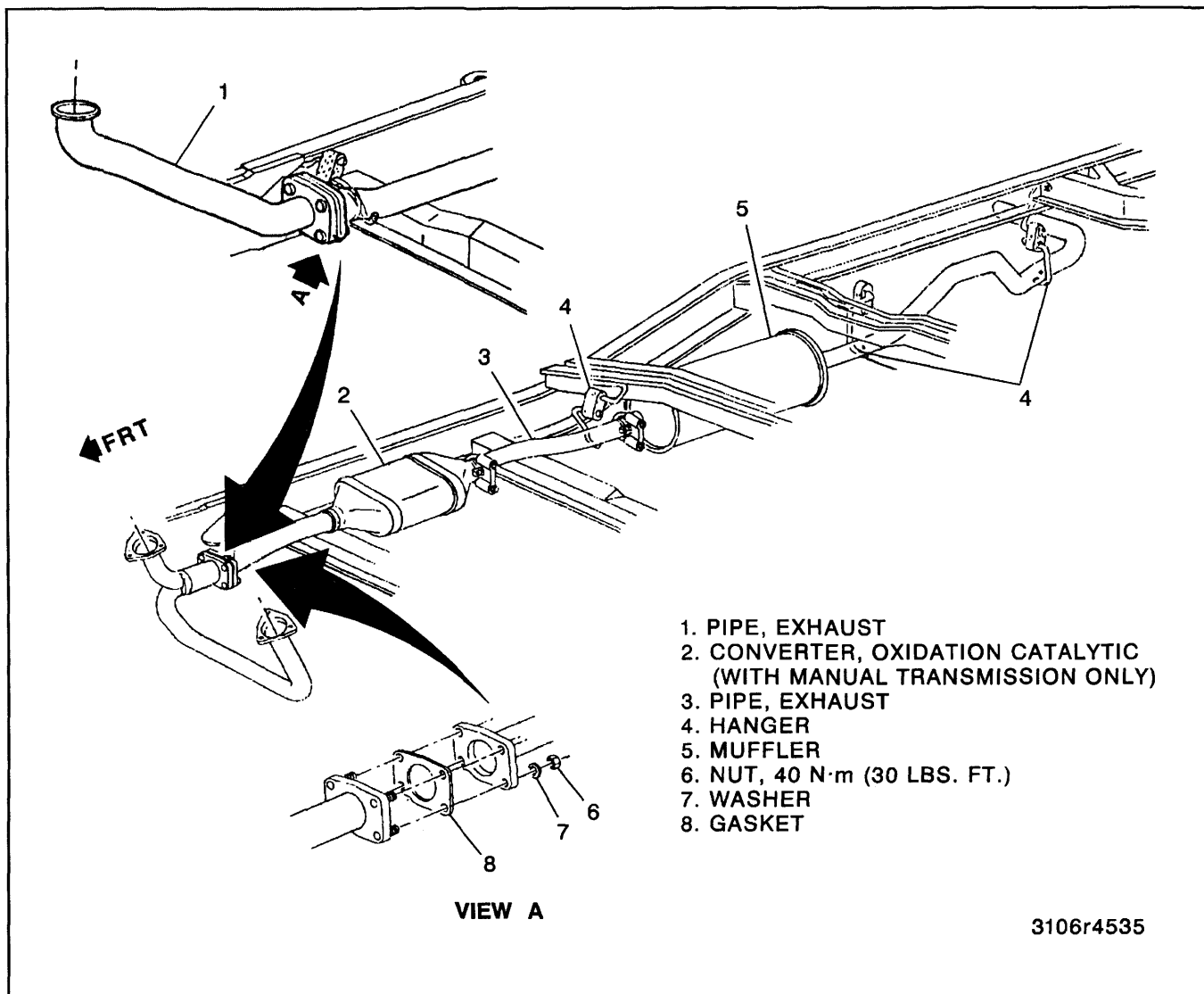


Figure 24—Exhaust System - CK 3/4 and 1 Ton, Regular Cab with 6.5L (L49, VIN P)

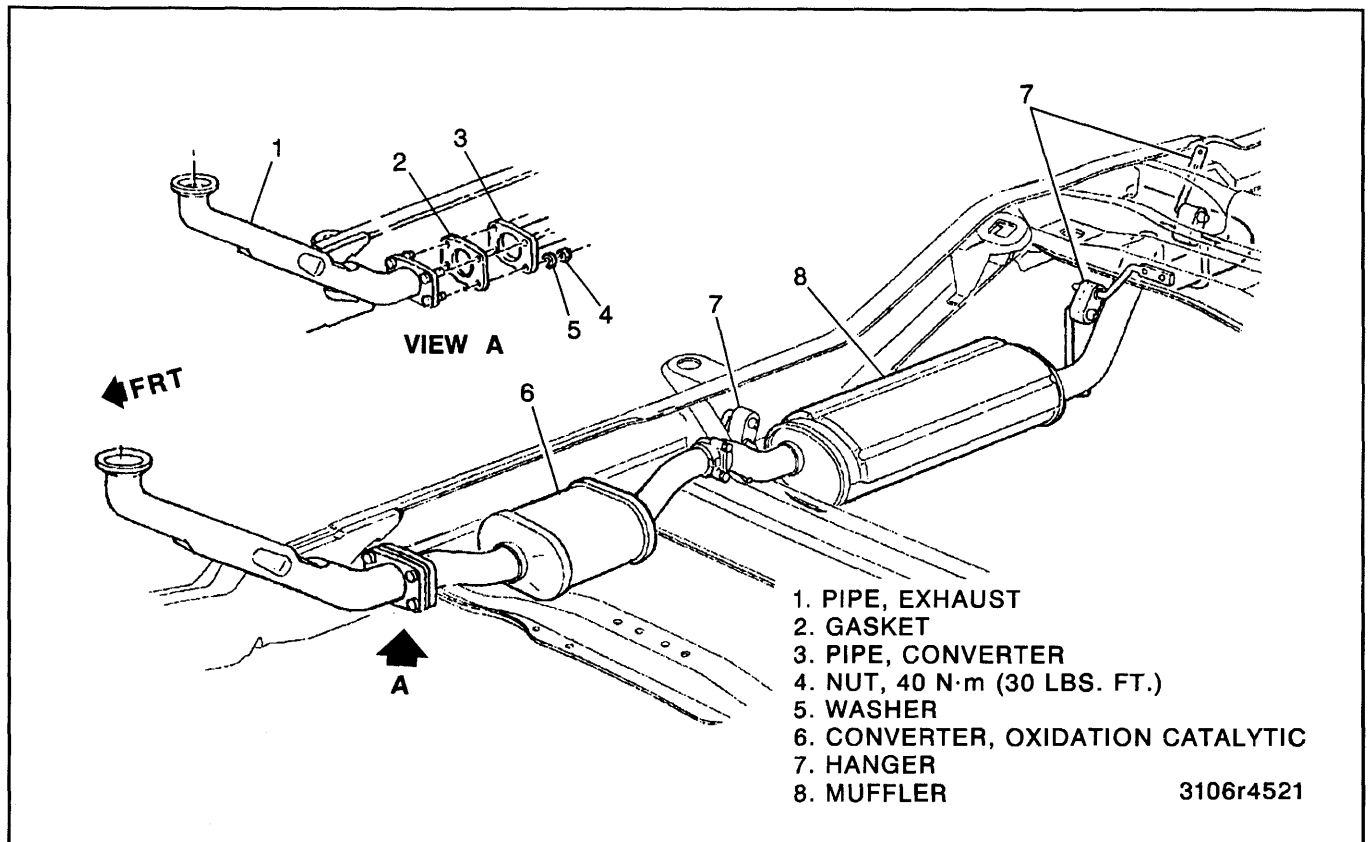


Figure 25—Exhaust System - K, Utility with 6.5L (L56, VIN S)

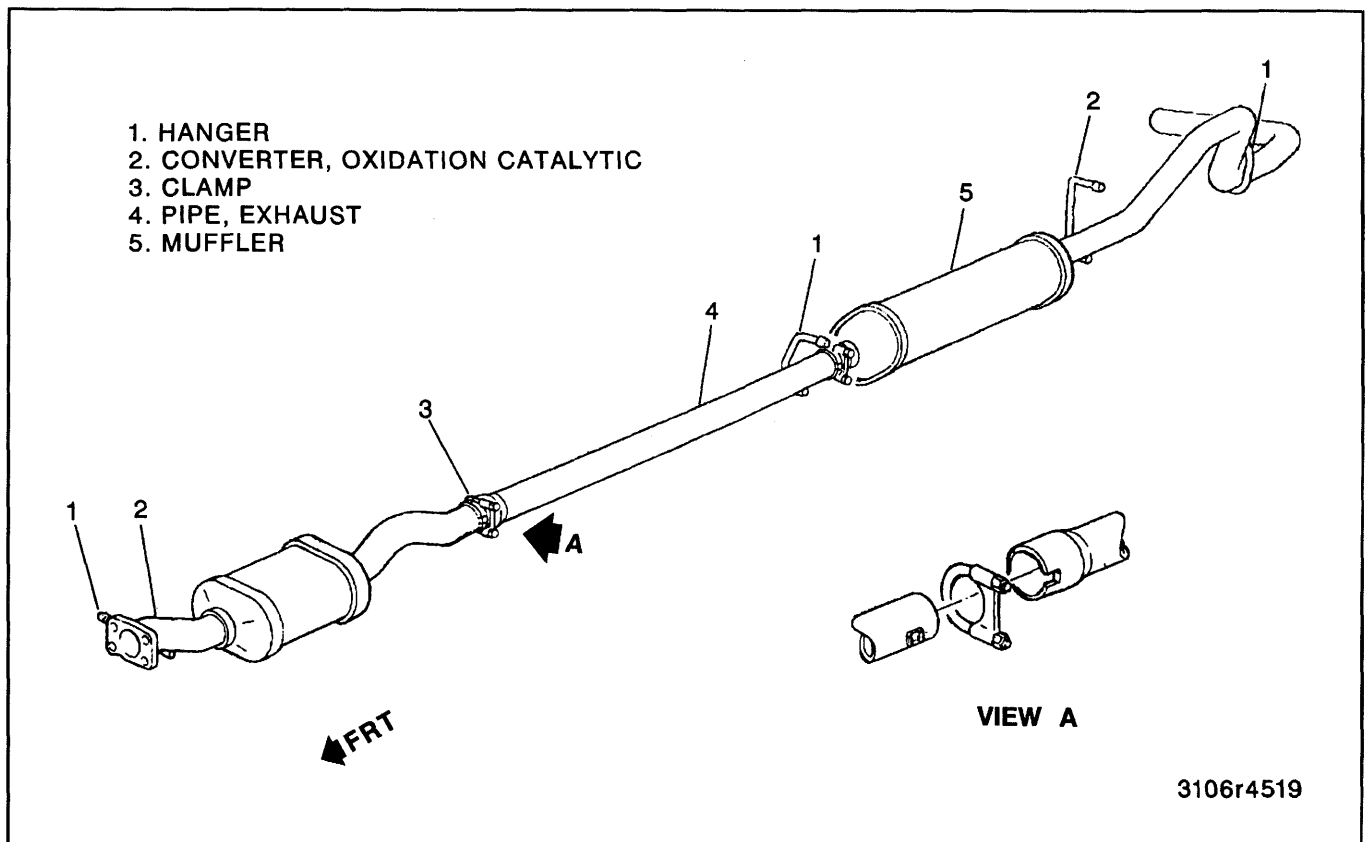


Figure 26—Exhaust System - CK, Crewcab with 6.5L (L65, VIN F)

6F-24 EXHAUST SYSTEM

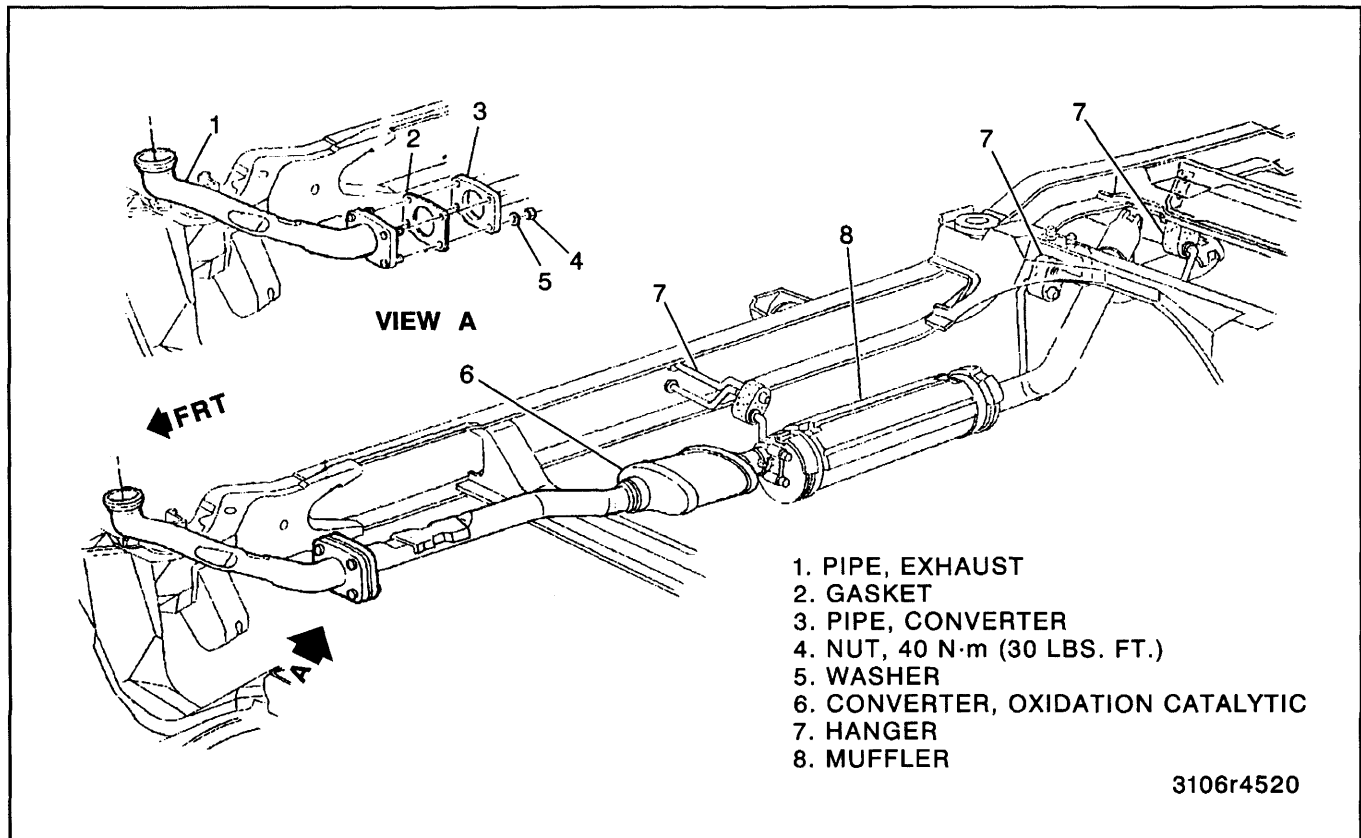


Figure 27—Exhaust System - Suburban with 6.5L (L56, VIN S and L65, VIN F)

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N·m	Lbs. Ft.	Lbs. In.
Catalytic Converter Hanger Bolt.....	45	33	—
Catalytic Converter to Exhaust Pipe Bolts.....	60	44	—
Catalytic Converter U-Bolt Nuts.....	60	44	—
Exhaust Pipe Hanger Bracket to Frame Bolts	45	33	—
Exhaust Pipe to Flange Nuts (Diesel Engines).....	40	30	—
Exhaust Pipe to Manifold Bolts (Diesel Engines).....	29	22	—
Exhaust Pipe to Manifold Bolts (Gasoline Engines).....	20	15	—
Exhaust V-Band Clamp.....	8	—	71
Hanger to Frame Bolt (Rod Type).....	35	26	—
Hanger to Frame Nut (Rod Type)	34	25	—
Muffler Hanger Clamp Nuts	41	30	—
Muffler Hanger to Frame Bolt.....	45	33	—
Tail Pipe Bracket to Frame Bolt	45	33	—
Tail Pipe Hanger Clamp Nut.....	41	30	—

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NOTES

SECTION 6H

VACUUM PUMPS

NOTICE: When fasteners are removed always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

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On-Vehicle Service	6H-3
Vacuum Pump Replacement	6H-3
Specifications	6H-6
Fastener Tightening Specifications.....	6H-6
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GENERAL DESCRIPTION

The vacuum pump is used on the light duty naturally aspirated (L49, VIN P), light duty turbocharged (L56, VIN S), and heavy duty turbocharged (L65, VIN F) 6.5L diesel engines to operate emission controls (EGR valve), cruise control, (if equipped), and heater doors. The diaphragm pump does not require periodic maintenance.

The pump is bracket mounted at the right front of the engine. It has a pulley attached that is driven by a multiple ribbed belt. With the exception of the pulley, the vacuum pump is replaced as an assembly. Refer to "Specifications" at the end of this section for vacuum pump applications.

DIAGNOSIS

Refer to figures 1 and 2 for diagnosis of the vacuum pump.

6H-2 VACUUM PUMPS

VACUUM PUMP DIAGNOSIS

BLOCK WHEELS, APPLY PARKING BRAKE, AND PLACE TRANSMISSION SELECTOR LEVER IN "PARK" OR "NEUTRAL" BEFORE STARTING ENGINE.

STEP 1

SEE "VACUUM PUMP DIAGNOSIS" ILLUSTRATION BELOW.
CONNECT A VACUUM GAGE TO THE VACUUM PUMP INLET.
WITH THE ENGINE IDLING, VACUUM SHOULD REACH—70 kPa (21 INCHES Hg)
MINIMUM AT SEA LEVEL WITHIN 30 SECONDS (REFER TO GRAPH FOR
VACUUM AT OTHER ELEVATIONS).

CHECKS OKAY. LEAK IN
SYSTEM OTHER THAN
VACUUM PUMP

GO TO STEP 2
ON NEXT PAGE

LOW VACUUM OR
FLUCTUATING GAGE
READING

1. CHECK GAGES AND CONNECTIONS FOR LEAKS.
2. CHECK BELT TENSION AND PULLEY FIT TO SHAFT ON DRIVE BELT MODELS.
3. CHECK IDLE RPM.

RECHECK VACUUM GAGE

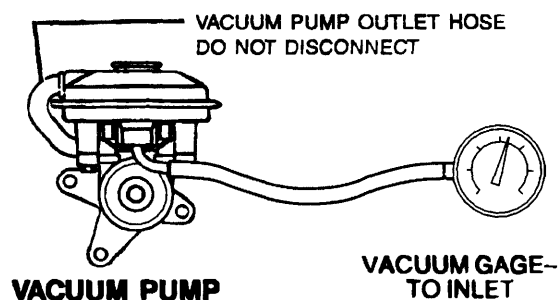
VACUUM O.K.

GO TO STEP 2

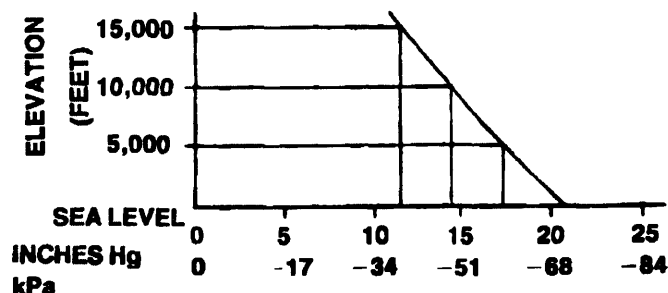
LOW VACUUM.
REPLACE
PUMP.

GO TO STEP 2
ON NEXT PAGE

VACUUM PUMP DIAGNOSIS



MINIMUM ACCEPTABLE vs ALTITUDE



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Figure 1—Diagnosis of Vacuum Pump

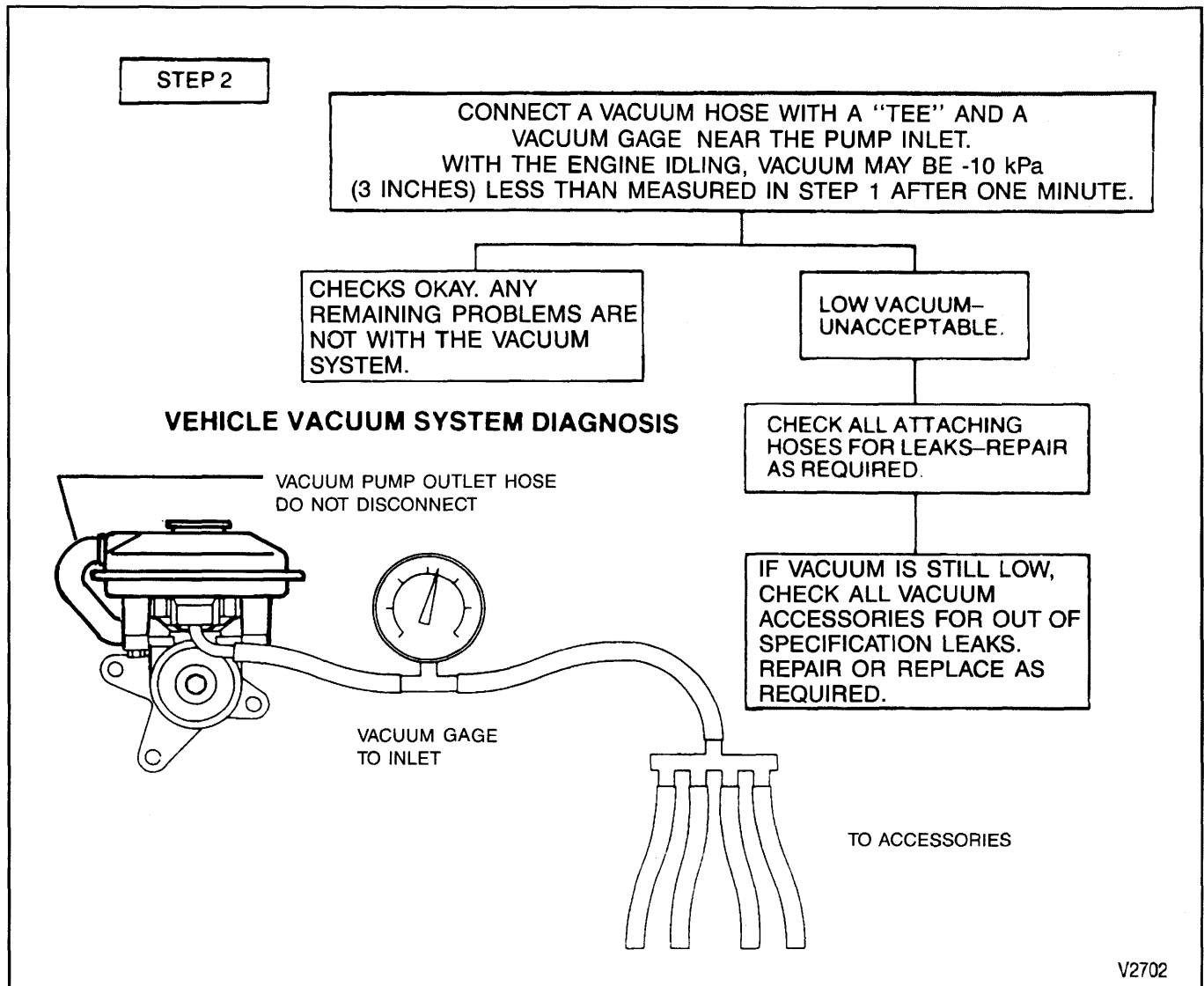


Figure 2—Diagnosis of Vacuum Pump

ON-VEHICLE SERVICE

VACUUM PUMP REPLACEMENT



Remove or Disconnect (Figures 3, 4, and 5)

- Make sure the engine control switch is off.
- 1. Drive belt.
- Vehicles with Air Conditioning:**
- 2. Electrical connector at the A/C compressor.
- 3. Three through bolts (7) holding the A/C compressor (9) to the bracket (10) (figure 3).
 - Do not remove the A/C lines.
- 4. A/C compressor out of the bracket and set it off to the right side.

- 5. Vacuum hose (15) off the vacuum pipe (14), leaving the hose attached to the pump (figure 5).
- 6. One through bolt (12) and two nuts (3) holding the bracket (10) to the stud on the engine (figure 3).
 - Access the lower nut through the hole in the vacuum pump pulley.
- 7. Vacuum pump (1) and bracket (10) assembly from the vehicle.
- Vehicles without Air Conditioning:**
- 8. Bolts holding the mounting bracket (10) to the engine (figure 4).
- 9. Nut holding the bracket to the stud on the engine.
- 10. Vacuum pump and the bracket from the engine.

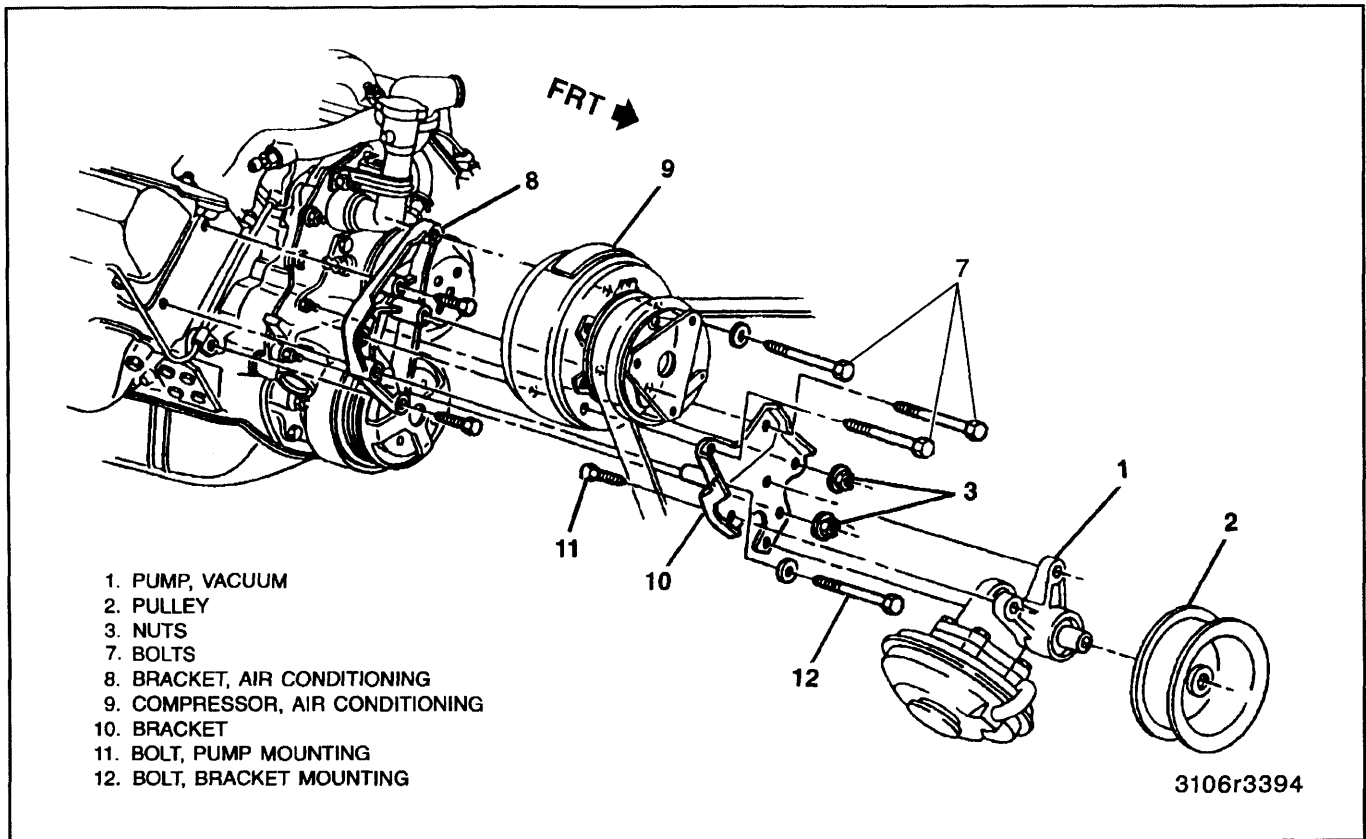


Figure 3—Vacuum Pump with Air Conditioning

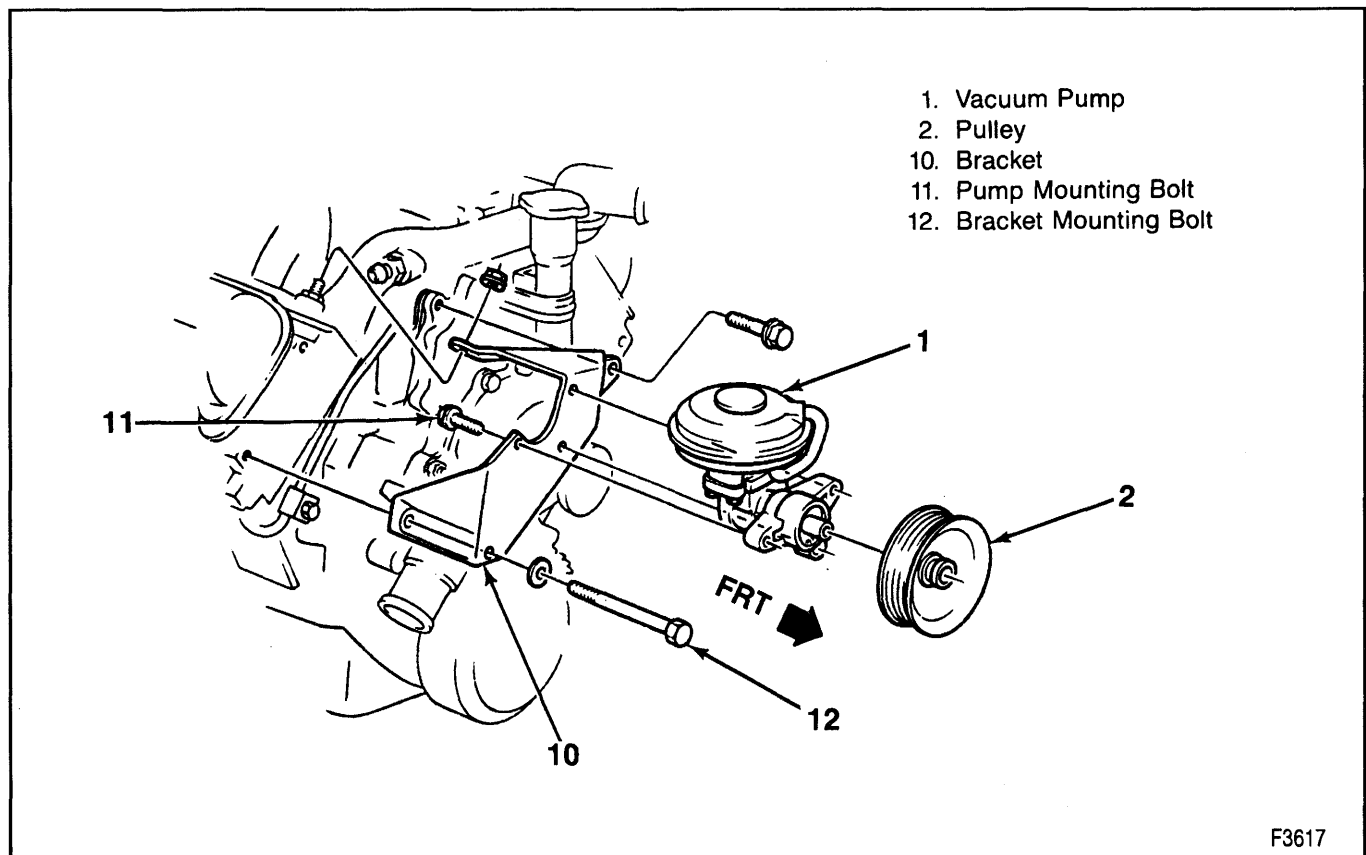


Figure 4—Vacuum Pump without Air Conditioning

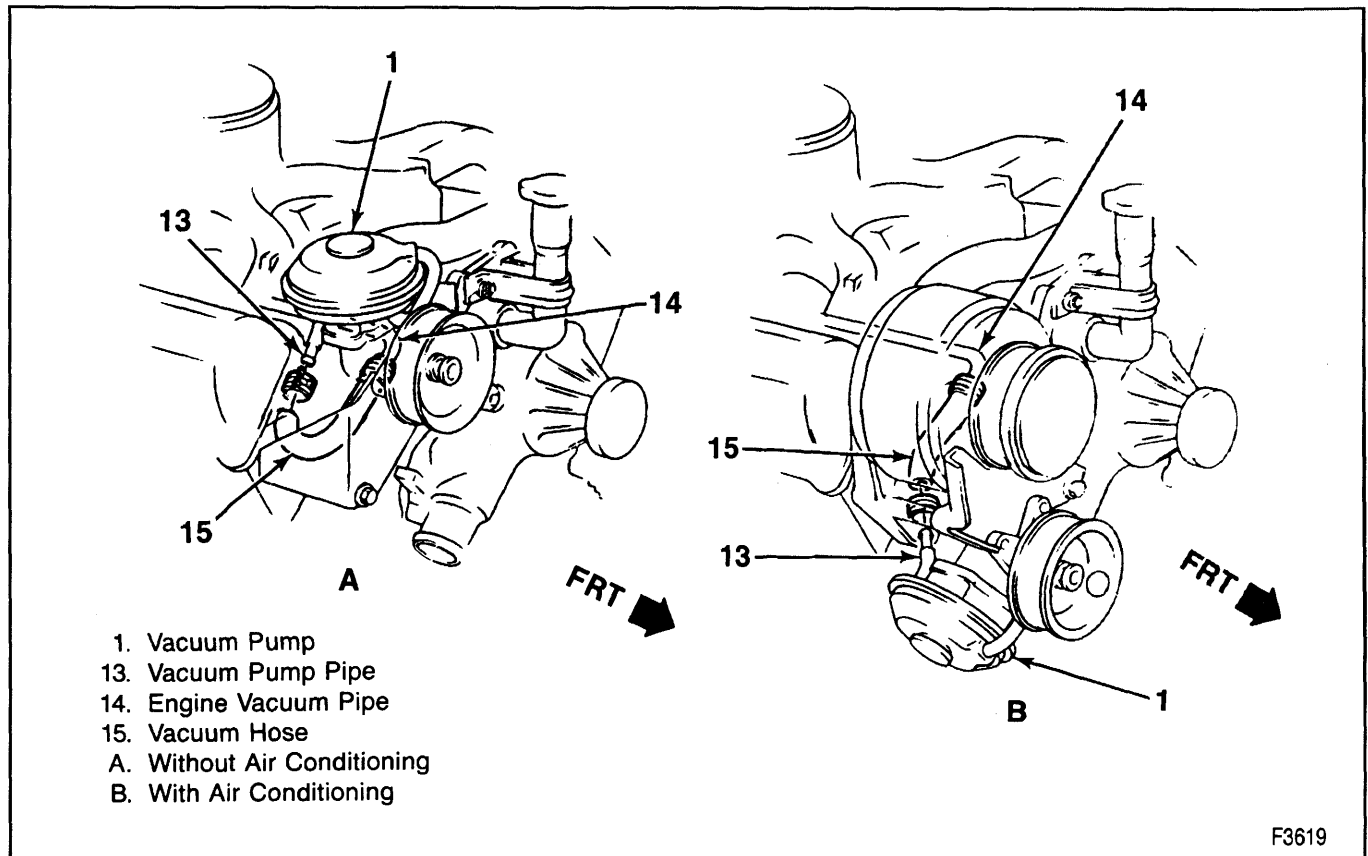


Figure 5—Vacuum Pump Hose



Disassemble (Figure 6)

Tool Required:

J 25034-B Pump Pulley Remover

• Clamp the vacuum pump bracket in a vise.

1. Vacuum pump hose (15) from the vacuum pump pipe.
2. Pulley (2) from the pump using J 25034-B.

NOTICE: Do not pry from the back of the pulley. Damage could occur to the pulley or pump.

3. Three bolts (11) from the back of the bracket.
4. Vacuum pump.



Assemble (Figure 7)

Tool Required:

J 25033-B Pump Installer

NOTICE: Refer to "Notice" on page 6H-1.

1. Vacuum pump to the bracket with bolts (11).



Tighten

- Bolts to 27 N.m (20 lbs. ft.).
2. Pulley to the pump using J 25033-B until the pulley is flush with the end of the shaft (figure 7).

NOTICE: Do not tap the pulley back onto the pump shaft. The pump could be damaged.

3. Vacuum hose (15) to the vacuum pump pipe (13).



Install or Connect

Vehicles without Air Conditioning:

NOTICE: For steps 1, 2, 4, and 7, refer to "Notice" on page 6H-1.

1. Vacuum pump (1) to the bracket (10) with bolts (11) (figure 4).



Tighten

- Bolts to 27 N.m (20 lbs. ft.).
2. Bracket and the pump to the engine with bolts (12) and nut.



Tighten

- Bolts to 40 N.m (30 lbs. ft.).
 - Nut to 40 N.m (30 lbs. ft.).
3. Vacuum hose (15) (figure 5).
- Vehicles with Air Conditioning:**
4. Vacuum pump and bracket assembly to the engine with bolt (12) and nuts (3).

6H-6 VACUUM PUMPS

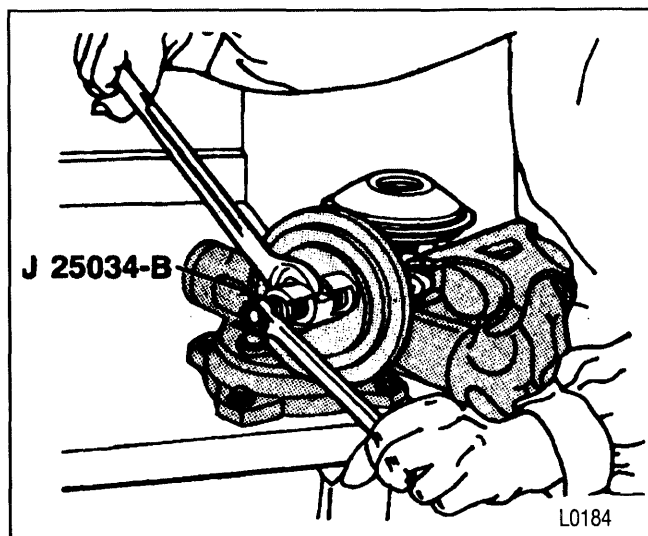


Figure 6—Removing the Pulley



Tighten

- Bolt to 40 N.m (30 lbs. ft.).
 - Nuts to 30 N.m (22 lbs. ft.).
5. Vacuum hose (15) to the engine vacuum pipe (14) (figure 5).
 6. A/C compressor into position on the engine.
 7. Bolts holding the compressor and bracket to the engine.

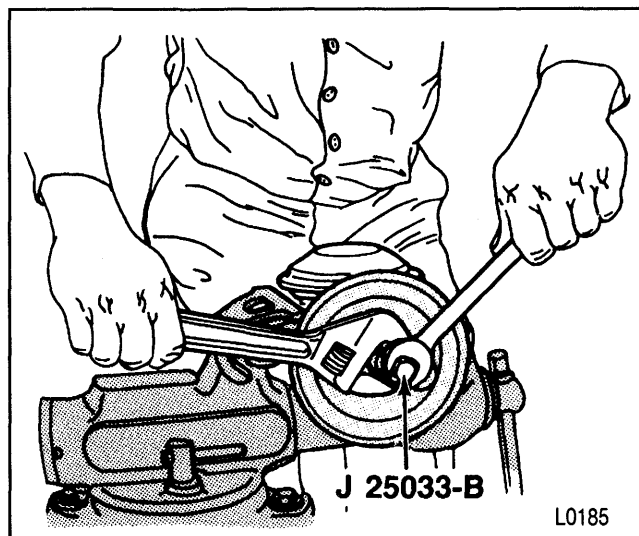


Figure 7—Installing the Pulley



Tighten

- Bolts to 40 N.m (30 lbs. ft.).
8. Electrical connector to the compressor clutch. **Both Models:**
 9. Drive belt.

SPECIFICATIONS

VACUUM PUMP APPLICATIONS

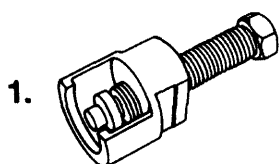
ENGINE
6.5L without A/C
6.5L with A/C

VACUUM PUMP
26036642
7849209

PULLEY
15589758
15589757

T2142

SPECIAL TOOLS



J 25034-B

2.



J 25033-B

1. Pump Pulley Remover
2. Pump Pulley Installer

F9310

SECTION 6J**TURBOCHARGER**

CAUTION: Turbochargers operate at high speeds and temperature. Do not operate the engine and/or turbocharger without all normally installed inlet piping and filters, along with all exhaust piping. Failure to install the above components could result in personal injury and damage to the vehicle.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number for the application. If the correct part number is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The turbocharger is used to increase the amount of air that enters the engine's cylinders. This increase allows a proportional increase in fuel to be injected into the cylinders resulting in increased power output, more complete combustion of fuel, and cooling of the cylinder heads, pistons, valves, and exhaust gas. This cooling effect helps extend engine life.

Heat energy and pressures in the engine exhaust gas are utilized to drive the turbine wheel (figure 1). Exhaust gas is directed to the turbocharger housing. The turbocharger housing acts as a nozzle to direct the exhaust gas flow to the turbine wheel blades which drive the shaft wheel assembly. Since the compressor wheel is attached directly to the shaft, it rotates at the same speed as the turbine wheel. Clean air from the air cleaner is drawn into the compressor housing and wheel where it is compressed and delivered through a

crossover pipe to the engine air intake manifold and then into the cylinders (figure 2). The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is regulated by a waste-gate valve in the exhaust housing.

The position of the waste-gate valve is controlled by the vehicle PCM which monitors turbo boost pressure. If increased boost is needed, more vacuum is applied to the actuator to close the waste-gate. If less turbo boost is needed, the vacuum applied to the actuator will be reduced allowing the waste-gate valve to open, resulting in additional exhaust bypassing the turbine wheel (figure 3).

For more information about vacuum operated wastegates controlled by the PCM, refer to the Driveability, Emissions, and Electrical Diagnosis Manual, NATEP-9442.

6J-2 TURBOCHARGER

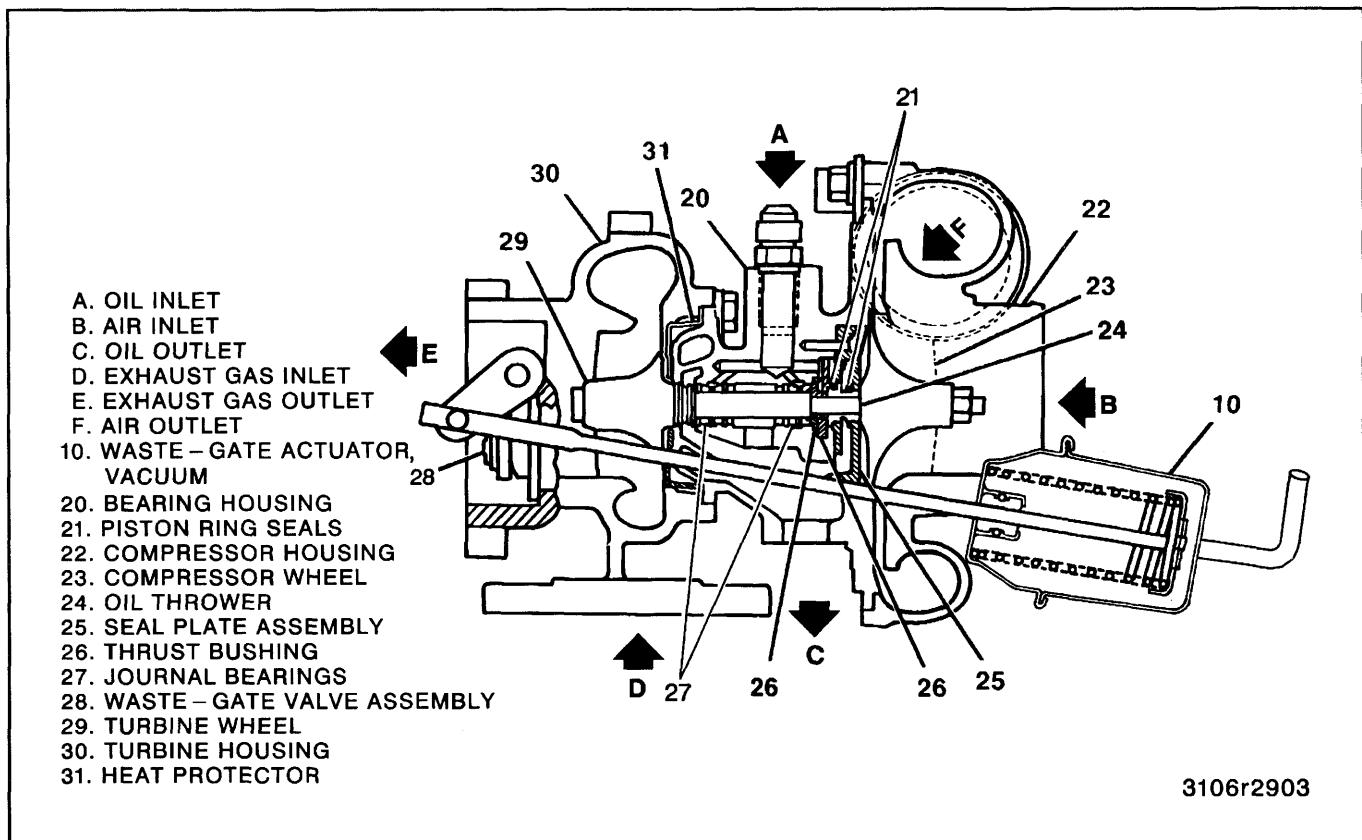
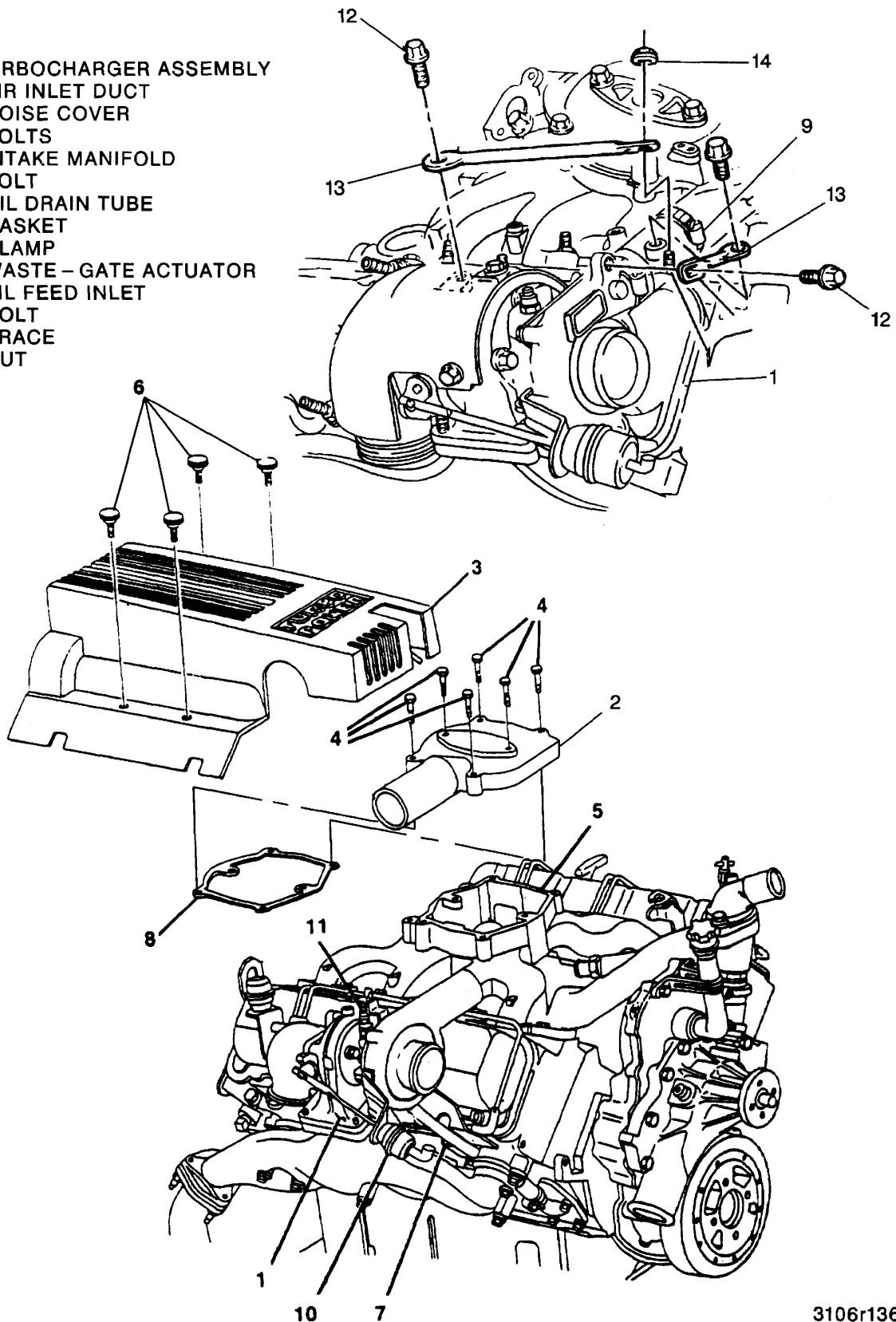


Figure 1—Turbocharger Component View

1. TURBOCHARGER ASSEMBLY
2. AIR INLET DUCT
3. NOISE COVER
4. BOLTS
5. INTAKE MANIFOLD
6. BOLT
7. OIL DRAIN TUBE
8. GASKET
9. CLAMP
10. WASTE - GATE ACTUATOR
11. OIL FEED INLET
12. BOLT
13. BRACE
14. NUT



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Figure 2—Turbocharger and Cover Assembly

6J-4 TURBOCHARGER

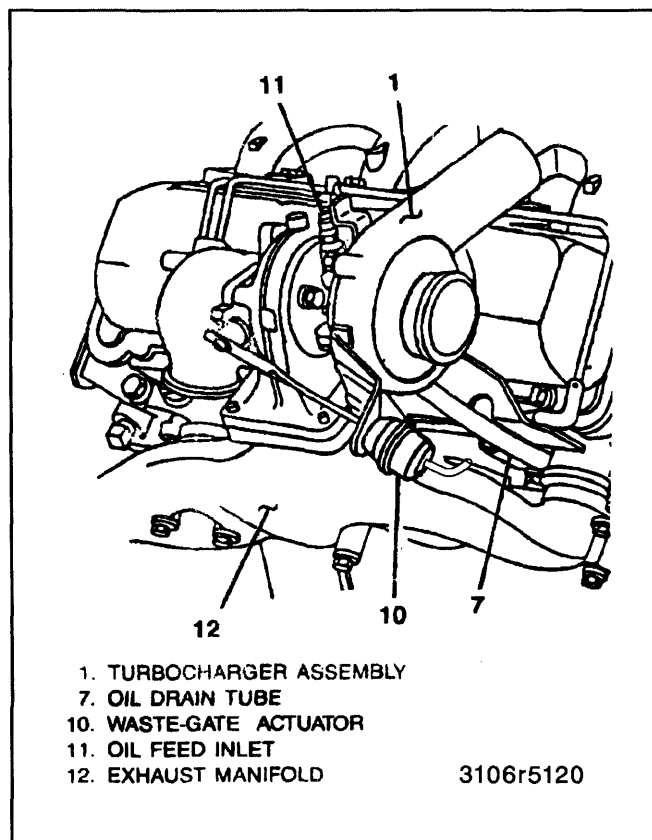


Figure 3—Turbocharger Assembly

DIAGNOSIS OF THE TURBOCHARGER

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine Lacks Power And Has No Black Smoke At Wide Open Throttle	1. Insufficient fuel supply to injection pump.	1. Refer to SECTION 6C and 6C2.
Engine Lacks Power And Has Black Smoke At Wide Open Throttle	1. Restricted air filter. 2. Obstructed air intake duct to turbocharger compressor wheel. 3. Air leak in compressor wheel inlet/outlet duct. 4. No vacuum signal to wastegate actuator. 5. Ruptured wastegate actuator diaphragm. 6. Air leak between intake manifold and engine. 7. Exhaust gas leak between cylinder head exhaust ports and turbine inlet. 8. Damaged turbocharger (Refer to "Inspection.") 9. Fuel system problem.	1. Replace air filter. 2. Remove obstruction(s). 3. Inspect inlet/outlet ducts for loose connections. Tighten connections and/or replace damaged duct work. 4. Check for DTCs. Refer to Driveability, Emissions, and Electrical Diagnosis Manual, NATP 9442. 5. Refer to "Inspection of the Wastegate Actuator Assembly." 6. Refer to SECTION 6A6 and SECTION 6F. 7. Repair leaks. 8. Find and correct cause of damage. Replace turbocharger if necessary. 9. Refer to SECTION 6C and SECTION 6C2.

DIAGNOSIS OF THE TURBOCHARGER (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Turbocharger Noise	1. Restriction and/or air leak in compressor inlet ducting and/or outlet ducting. 2. Rotating components of turbocharger out of balance. 3. Compressor and/or turbine wheel contacting housing. Refer to "Inspection."	1. Inspect compressor inlet/outlet ducting. Remove any restrictions. Tighten connections and/or replace any damaged duct work. 2. Replace turbocharger. 3. Locate reason for damage and replace turbocharger.
Blue Exhaust Smoke—Warm Engine Only	1. Lack of intake air. 2. Restricted oil drain tube. 3. Oil leakage past turbine side seal. (Refer to "Inspection.") 4. Oil leakage past compressor side seal. (Refer to "Inspection.")	1. Refer to SECTION 6C. 2. Clean or replace oil drain tube. 3. Replace turbocharger. 4. Replace turbocharger.

D0252

INSPECTION

Turbochargers are extremely reliable units. The majority of inoperative turbochargers are caused by dirt in the oil, oil lag (lack of oil flow), foreign objects or debris entering the turbocharger, and plugged or restricted air cleaner systems.

Lack of power, black smoke, blue smoke (excess oil consumption), or other engine performance problems are frequently blamed on the turbocharger when the actual cause is really another engine component. This is why a complete inspection of the turbocharger and all other engine components that may cause similar conditions must be examined before replacing the turbocharger. Refer to SECTION 6A for diagnosing engine problems other than those caused by the turbocharger. The following steps and the preceding diagnostic chart will aid in diagnosing problems caused by the turbocharger. If it is determined that the turbocharger is the cause of the problem it must be replaced. **Service of the turbocharger is not recommended.**



Inspect

- A high pitched whine may indicate an exhaust leak or a leak in the air induction system.
- A cycling up and down in pitch often indicates a blockage in the air inlet duct, a restricted air cleaner, or a build up of dirt on the compressor wheel of the turbocharger.
- A sharp, high pitched scream may indicate that the bearings have deteriorated and one (or both) of the wheels is rubbing on its housing.
- At the compressor wheel blades (figures 4 through 7). There should not be any bent, broken, eroded, or cracked wheel blades.
- At the housing for signs of rubbing.
- At the compressor wheel for a build-up of dirt.
- For oil leaks into the turbocharger housing.



Important

- With this engine application, the inside of the air intake duct (rubber inlet elbow), turbocharger compressor wheel and housing can be quite oily, due to the venting of the crankcase vapors into the air intake system. This is considered normal.

Some of the problems that can cause oil leaks in excess into the turbocharger housing are:

- A. Too much idling of the engine.
- B. Obstructed air intake ducting or clogged air filter.
- C. Plugged or kinked oil drain tube from the turbocharger.
- D. Sludged oil accumulations in the center housing.
- E. Damage to turbocharger bearings or wheels.

CAUTION: Do not feel any components of the turbocharger while the engine is running. Make sure that the turbocharger has stopped rotating and the turbocharger and engine have cooled down before handling. Rotating parts and extreme heat may cause serious personal injury if handled.

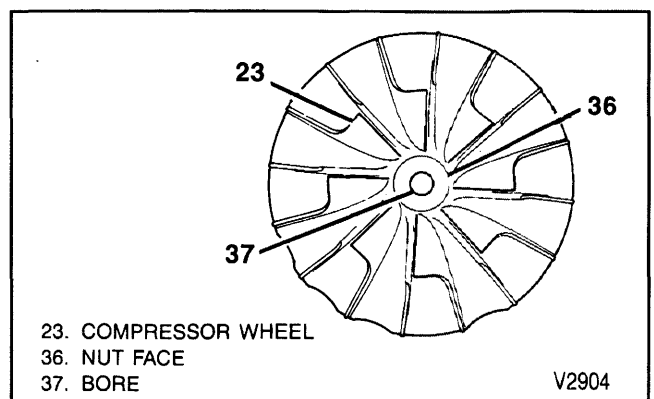


Figure 4—Normal Compressor Wheel

6J-6 TURBOCHARGER

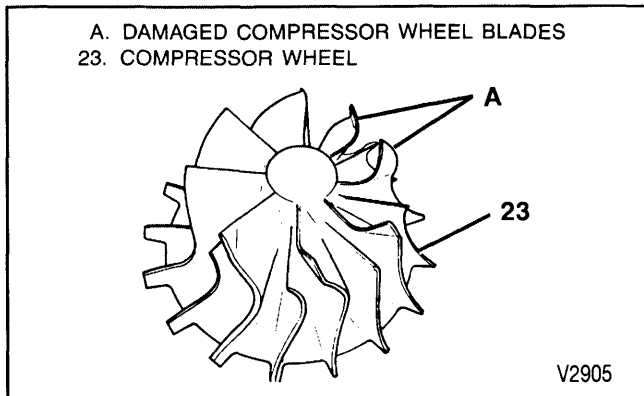


Figure 5—Damage by a Soft Object

- Carefully grasp the compressor wheel nut with fingers and rotate the wheel in a clockwise direction. It should turn freely with no signs of binding or scraping (housing contact).
- How the turbocharger rotates while pushing in and pulling out on the compressor wheel; it should rotate freely with no contact with the housing.
- Carefully grasp the compressor wheel nut with fingers and while rotating move the wheel up and down (radially). There should be no compressor wheel to housing contact. **Note: axial and radial play is normal even on a new turbocharger.** If compressor wheel to housing contact exists, it will be very evident when rotating the wheel. The wheel will drag or scrape on the housing surface and visual damage will probably be evident on the wheel blades and housing surface.

! Important

If the turbocharger does not pass any one of the above inspections that indicate damage to the turbocharger, with the exception of the waste-gate actuator, then the turbocharger must be replaced. See "Inspection of the Waste-Gate Actuator."

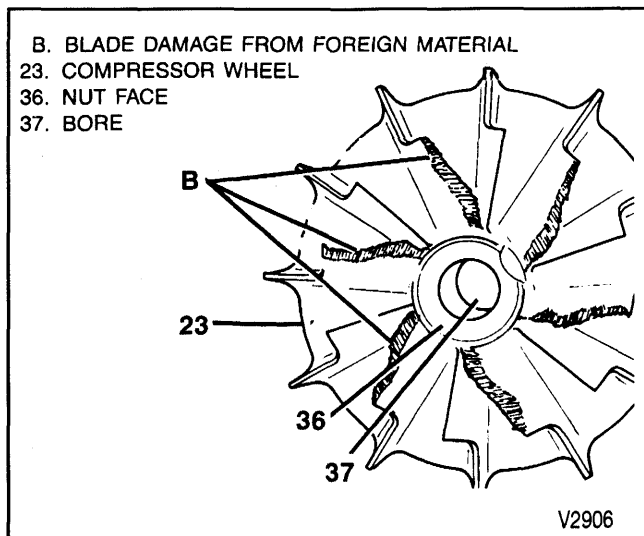


Figure 6—Damage by a Hard Object

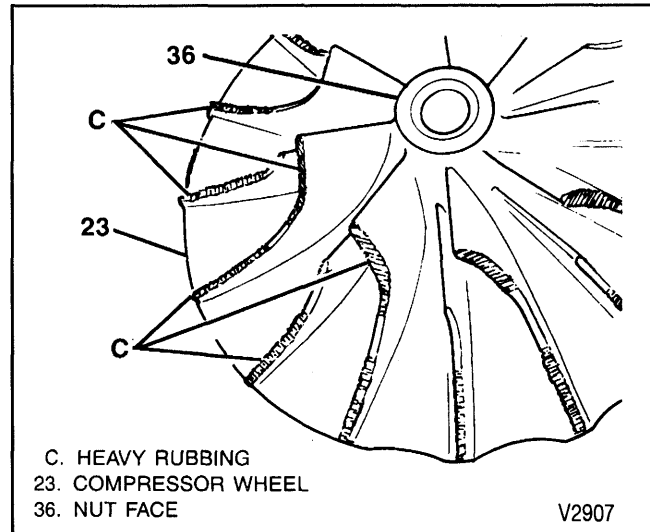


Figure 7—Compressor Blades Show Heavy Rubbing

INSPECTION OF THE WASTE-GATE ACTUATOR ASSEMBLY

The waste-gate actuator assembly can be replaced separately from the turbocharger assembly. To check operation of the waste-gate actuator (figures 1 and 2):

Tool Required:

J 23738 Hand Operated Vacuum Pump

1. With the engine off, inspect actuator rod and lever. The actuator rod and lever should move back and forth without any tension.
2. Apply 5 inches HG vacuum to actuator, actuator rod and lever should close the waste-gate. Look for the rod to move toward the front of the engine.

If the rod does not snap back to a closed position, the waste-gate actuator is defective and should be replaced. For removal of the waste-gate actuator, refer to "Waste-Gate Actuator Replacement."

BOOST PRESSURE TEST

Tools Required:

J 39307 Adapter J 28474 Turbo Compound Gage

CAUTION: Do not perform this test with anyone in the area around the vehicle. The wheels of the vehicle should be blocked to prevent the vehicle from moving forward. Failure to take proper precautions may result in personal injury and damage to the vehicle.

1. Remove the front center mounting bolt from air inlet and install J 39307 adapter with a 6 to 7 foot length of 3/16 inch I.D. rubber line. Then route the rubber line into the cab and connect J 28474 pressure gage to the end of the line.

2. Test drive the vehicle with a passenger watching the gage. Allow the vehicle to coast at engine idle speed in first gear. Then press the accelerator pedal to the floor while the passenger notes the boost pressure reading. A boost reading of 14 kPa (2 psi) or more indicates the turbocharger is operating properly.

NOTICE: The 14 kPa (2 psi) reading is for quick accelerations only. The pressure reading can climb above 14 kPa (2 psi) under heavy loads. During deceleration, the pressure reading may even go down.

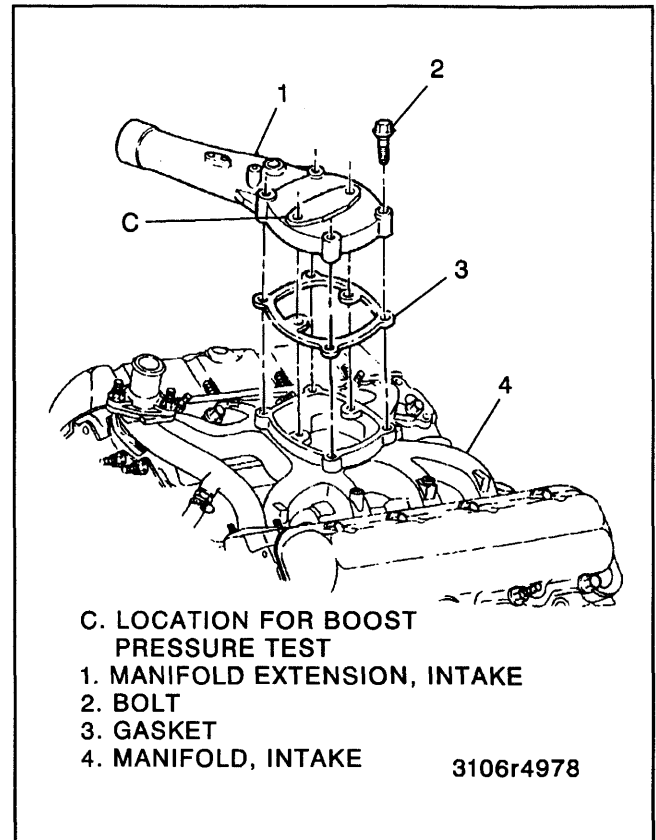


Figure 8—Boost Pressure Test Location

ON-VEHICLE SERVICE

TURBOCHARGER REPLACEMENT

The turbocharger assembly consists of the turbocharger housing, internal components, the waste-gate actuator, exhaust elbow, and heat shield.

↔ Remove or Disconnect (Figures 2, 9, 10, and 11)

1. Negative battery cables. Refer to SECTION 0A.
2. Upper intake manifold cover.
3. Self tapping screw holding CDR valve tube on top of turbocharger.
4. CDR valve and tube assembly from the air cleaner extension and right rocker cover. Refer to SECTION 6A6.

! Important

- Usually some quantity of oil will exist inside the vent system. The crankcase vapor consists of vaporized oil that condenses within the vent and intake system. The inside of the air intake duct (rubber inlet elbow) and compressor wheel housing can be quite oily due to the venting of the crankcase vapors.
5. Air cleaner extension (rubber elbow) from air cleaner and compressor inlet.

6. Two bolts retaining the air cleaner to the wheel well and lift the air cleaner assembly off the front air intake duct.

- This will allow easier access to the turbocharger flange nuts and exhaust clamp.

NOTICE: The right front wheel and inner splash shield can be removed for easier access to the turbocharger back flange nut. Refer to SECTION 3E.

7. Vacuum hose to the waste-gate actuator.
8. Long and short turbocharger braces (figure 2).
9. Hose clamps at intake extension/turbocharger compressor connector hose.

- Slide connector hose over intake extension.

10. Exhaust clamp at turbocharger (figure 9).
11. Oil feed hose.
12. Oil return pipe (figure 11).
13. Turbocharger flange nuts (figure 10).
14. Turbocharger assembly from exhaust manifold.

↔ Install or Connect (Figures 9, 10, 11, and 12)

NOTICE: For steps 2, 3, 4, 5, 7, 8, 9, 11, 12, and 14, refer to "Notice" on page 6J-1.

6J-8 TURBOCHARGER

! Important

Before the turbocharger is installed, perform the following steps:

- A. Check the intake and exhaust systems leading to and from the turbocharger to ensure that there is no foreign debris. Even small debris can cause severe wheel damage if inducted during high speed operation.
 - B. Make sure the turbocharger and exhaust manifold flanges are clean and free of any foreign material. Use a high temperature anti-seize compound (GM P/N 1052771) or equivalent on all threaded fasteners connected to the turbocharger (figure 9).
1. Turbocharger assembly to the exhaust manifold (figure 10).
 2. Nuts to exhaust manifold.

⌚ Tighten

- Exhaust manifold mounting nuts to 50 N.m (37 lbs. ft.).
3. Gasket on oil return pipe. Then the oil return pipe to the bottom of the turbocharger (figure 11).

⌚ Tighten

- Oil drain tube bolts to 26 N.m (19 lbs. ft.).

! Important

- Fill the oil feed hole at the top of the turbocharger with a small amount of engine oil (1 to 2 cc) while hand rotating the compressor wheel. This action will lubricate the turbocharger shaft bearings.
4. Oil feed hose to top of turbocharger.

⌚ Tighten

- Oil feed hose fitting to 17 N.m (13 lbs. ft.).
5. Exhaust pipe to turbocharger with clamp (figure 12).

⌚ Tighten

- Exhaust pipe clamp to 8 N.m (71 lbs. in.).

! Important

- When starting the engine, allow it to idle for two minutes so oil can flow into the oil feed hose.
6. Inner splash shield and right front wheel (if removed).

! Important

- Apply silicone sealant (GM P/N 9985675) or equivalent to turbocharger compressor outlet hose before installation to prevent oil leakage from the closed breather system.
7. Slide the connector hose over the compressor outlet. Make sure the connector hose is centered between the compressor outlet and the inlet extension housing.

⌚ Tighten

- Connector hose clamps to N.m 1.7 (15 lbs. in.).
8. Long turbocharger brace by guiding the flat end of the brace under the heater inlet.
 9. Nut onto the stud.
 10. Bolt into the bent end of the brace.

⌚ Tighten

- Long turbocharger brace nut to 34 N.m (26 lbs. ft.).
 - Long turbocharger brace bolt to 50 N.m (37 lbs. ft.).
11. Short turbocharger brace to extension and compressor housing.
 12. Short turbocharger brace bolts.

⌚ Tighten

- Short turbocharger brace bolts to 25 N.m (19 lbs. ft.).
13. Vacuum hose to waste-gate actuator.
 14. Slide air cleaner onto the front air inlet duct and attach it to the fenderwell.
 15. Large diameter air cleaner bolt.
 16. Short diameter air cleaner bolt.

⌚ Tighten

- Larger diameter air cleaner bolt to 30 N.m (22 lbs. ft.).
- Smaller diameter air cleaner bolt to 5 N.m (45 lbs. in.).

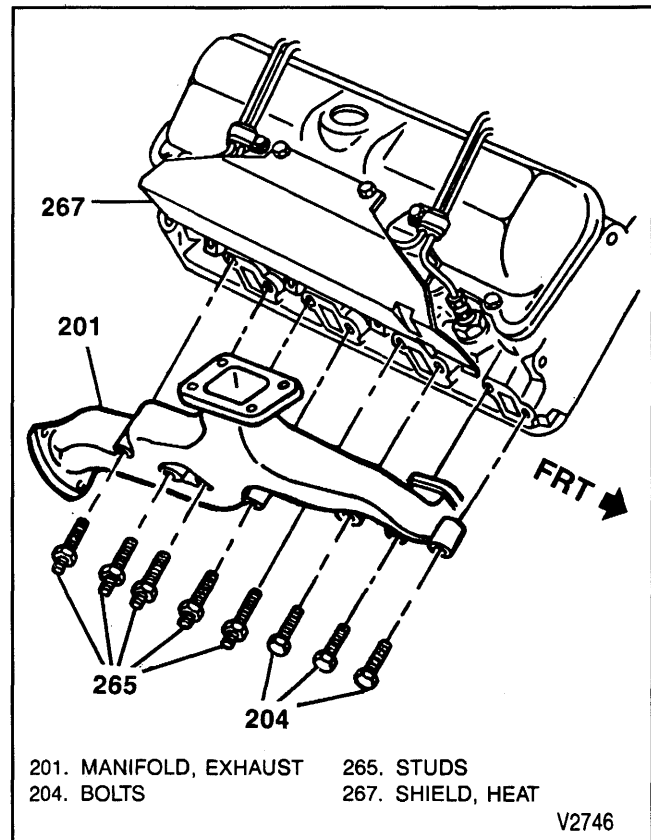
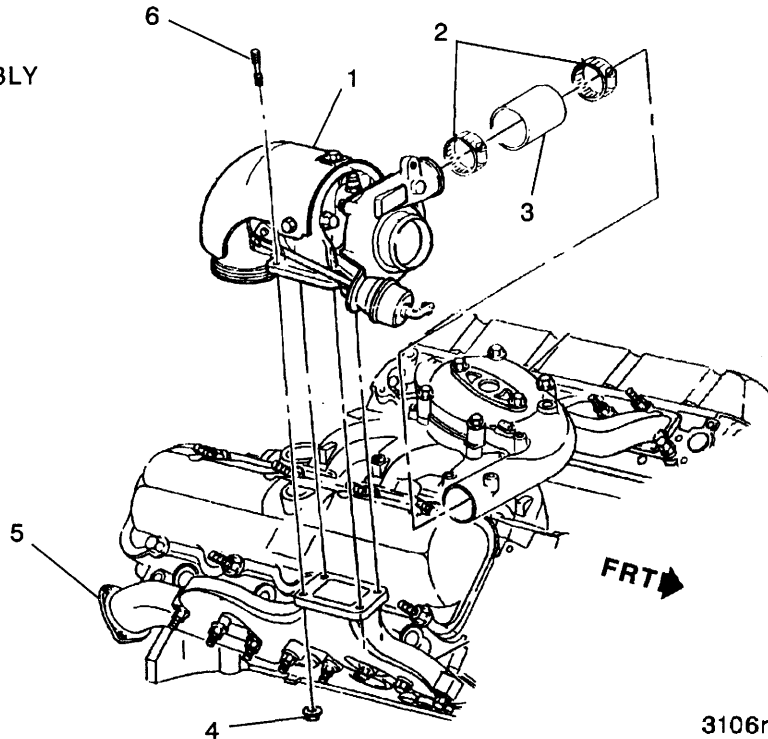


Figure 9—Exhaust Manifold and Heat Shield

1. TURBOCHARGER, ASSEMBLY
2. CLAMP
3. CONNECTOR, RUBBER
4. NUT
5. MANIFOLD, EXHAUST
6. STUD



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Figure 10—Turbocharger Mounting

17. Air cleaner extension (rubber elbow) onto air cleaner and compressor inlet.



Tighten

- Extension clamps to 1.7 N.m (15 lbs. in.).
18. CDR valve and tube assembly on right rocker cover and extension.
 - Start self-tapping screw through CDR tube bracket and thread into bracket on turbocharger housing.
 19. Upper intake manifold cover.
 20. Intake manifold cover bolts.



Tighten

- Intake manifold cover bolts to 11 N.m (90 lbs. in.).
21. Negative battery cable.



Important

- Run engine at idle for at least 2 minutes after completing the installation of the turbocharger. While running the engine, check for any oil leaks at the oil supply and return hoses.

WASTE-GATE ACTUATOR REPLACEMENT



Remove or Disconnect (Figure 13)

1. Vacuum hose.
2. E-clip retainer from the waste-gate lever pin.

- Access may be improved by removing the turbocharger heat shield.

3. Two waste-gate bracket mounting bolts.
4. Waste-gate actuator.



Install or Connect (Figure 13)

NOTICE: For steps 3 and 5, refer to "Notice" on page 6J-1.

1. Waste-gate actuator assembly to turbocharger.
2. Shaft pin into lever hole.
3. Two mounting bolts through the waste-gate bracket. Use a sealant on the bolt threads.



Tighten

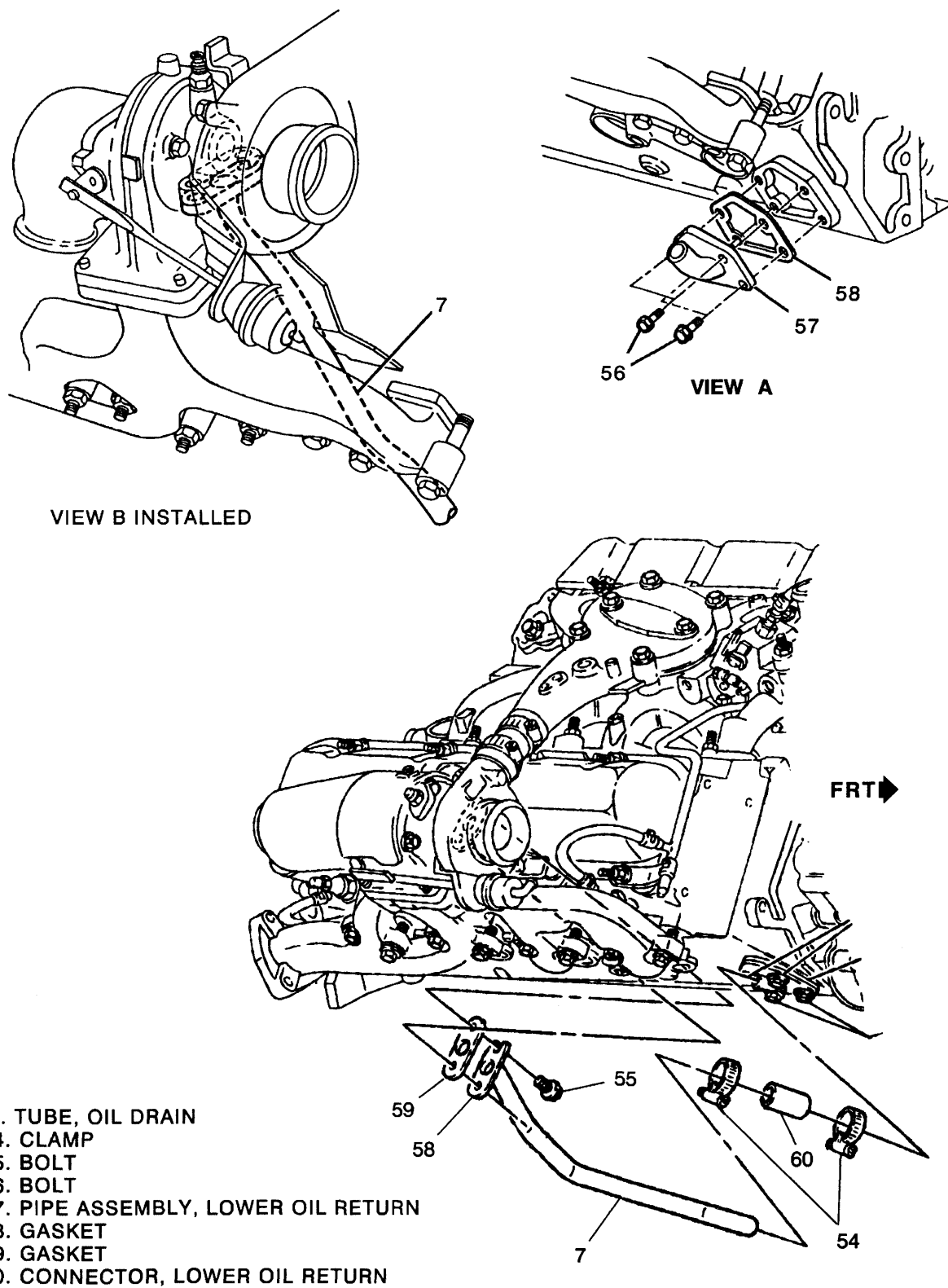
- Bolts to 23 N.m (17 lbs. ft.).
4. New E-clip on shaft pin.
 5. Heat shield (if removed). Use loctite on the heat shield bolts.



Tighten

- Bolts to 6 N.m (56 lbs. in.).
6. Vacuum line to wastegate actuator.

6J-10 TURBOCHARGER



3106r2909

Figure 11—Oil Drain (Return) Tube

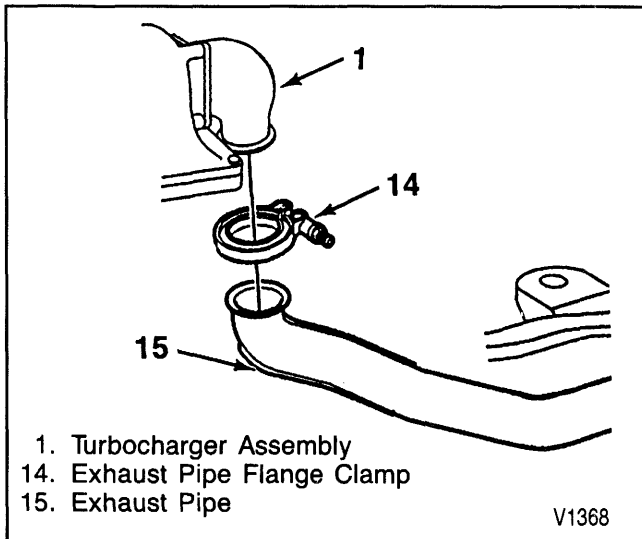


Figure 12—Exhaust Connection

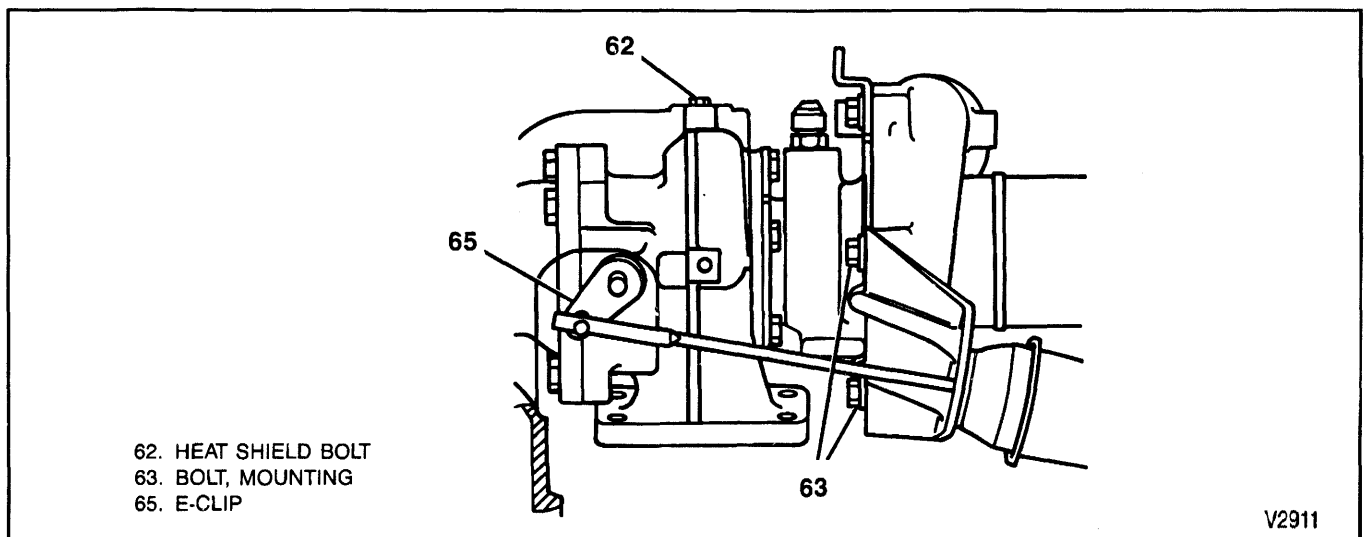


Figure 13—Actuator Assembly Mounting

SPECIFICATIONS**FASTENER TIGHTENING SPECIFICATIONS**

Fastener	N-m	Lbs. Ft.	Lbs. In.
Actuator Bracket Bolts	23	17	—
Air Cleaner			
Large Bolt.....	30	22	—
Smaller Bolt.....	5	—	45
Exhaust Clamp	8	—	71
Extension (Air Intake) Bolts	23	17	—
Heat Shield Bolts	6	—	56
Oil Drain Tube (Return) Flange Bolts	26	19	—
Oil Feed Line.....	17	13	—
Rubber Connector Hose Clamps.....	1.7	—	15
Rubber Inlet Elbow Clamps.....	1.7	—	15
Turbo Brace			
Long Type			
Bolt.....	50	37	—
Nut.....	34	26	—
Short Type			
Bolt.....	25	19	—
Turbocharger to Exhaust Manifold Nuts (50).....	50	37	—
Upper Intake Manifold Cover Bolts	11	—	90

T2853

SPECIAL TOOLS

1. HAND OPERATED VACUUM PUMP
2. TURBO COMPOUND GAGE
3. TURBO BOOST PRESSURE GAGE ASSEMBLY

3106r4979

TRANSMISSION

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7-2 TRANSMISSION

SECTION 7A-14A

HYDRA-MATIC 4L60-E

AUTOMATIC TRANSMISSION DIAGNOSIS

RPO M30

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GENERAL INFORMATION

HOW TO USE THIS SECTION

This section provides general information on transmissions, a detailed description of the operation of the HYDRA-MATIC 4L60-E and procedures for diagnosing the HYDRA-MATIC 4L60-E. When diagnosing any condition on the HYDRA-MATIC 4L60-E, begin with the "HYDRA-MATIC 4L60-E Functional Test Procedure" in this section. After the cause of a condition is determined, refer to SECTION 7A-14B, "ON-VEHICLE SERVICE" for repair procedures.

TRANSMISSION DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations are provided to establish a common language for describing transmission related conditions. These terms are used in SECTION 7A-14B.

Throttle Positions

- Minimum Throttle – the least amount of throttle opening required for an upshift.

- Light Throttle – approximately 1/4 of accelerator pedal travel. (25% Throttle Position)
- Medium Throttle – approximately 1/2 of accelerator pedal travel. (50% Throttle Position)
- Heavy Throttle – approximately 3/4 of accelerator pedal travel. (75% Throttle Position)
- Wide Open Throttle (WOT) – full travel of the accelerator pedal. (100% Throttle Position)
- Full Throttle Detent Downshift – a quick apply of the accelerator pedal to its full travel, forcing a downshift.
- Zero Throttle Coastdown – a full release of the accelerator pedal while the car is in motion and in drive range.
- Engine Braking – a condition where the engine is used to slow the car by manually downshifting during a zero throttle coastdown.

Shift Conditions

- Bump – a sudden and forceful apply of a clutch or band.
- Chuggle – a bucking or jerking may be most noticeable when the converter clutch is engaged; similar to the feel of towing a trailer.

- Delayed – a condition where a shift is expected but does not occur for a period of time. Samples of this could be described as clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator or, when manually downshifting to a lower range. Also defined as “LATE” or “EXTENDED”.
- Double Bump (Double Feel) – two sudden and forceful applies of a clutch or band.
- Early – a condition where the shift occurs before the car has reached proper speed. Tends to labor the engine after the upshift.
- End Bump – a firmer feel at the end of a shift as compared to the feel at the start of the shift. Also defined as “END FEEL” or “SLIP BUMP”.
- Firm – a noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. Should not be confused with “HARSH” or “ROUGH”.
- Flare – a quick increase in engine rpm along with a momentary loss of torque. This most generally occurs during a shift. Also defined as “SLIPPING”.
- Harsh (Rough) – a more noticeable apply of a clutch or band as compared with “FIRM”. This condition is considered undesirable at any throttle position.
- Hunting – a repeating quick series of upshifts and downshifts that causes a noticeable change in engine rpm. An example could be described as a 4-3-4 shift pattern. Also defined as “BUSYNESS”.
- Initial Feel – a distinct firmer feel at the start of a shift as compared to the finish of the shift.
- Late – a shift that occurs when the engine is at a higher than normal rpm for a given amount of throttle.
- Shudder – a repeating jerking condition similar to “CHUGGLE” but more severe and rapid. This condition may be most noticeable during certain ranges of car speed.
- Slipping – a noticeable increase in engine rpm without a car speed increase. A slip usually occurs during or after initial clutch or band apply.
- Soft – a slow, almost unnoticeable clutch or band apply with very little shift feel.
- Surge – a repeating engine related condition of acceleration and deceleration that is less intense than “CHUGGLE”.
- Tie-Up – a condition where two opposing clutches and/or bands are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine rpm.

Noise Conditions

- Planetary Gear Noise – a whine related to car speed most noticeable in first gear or reverse. Becomes less noticeable after an upshift.
- Pump Noise – a high pitch whine that increases with engine rpm.

Abbreviations

- PCM – Powertrain Control Module.
- TCC – Torque Converter Clutch.
- TP Sensor – Throttle Position Sensor.
- ECT Sensor – Engine Coolant Temperature Sensor.
- VS Sensor – Vehicle Speed Sensor.
- RWD – Rear Wheel Drive.
- 2WD – 2 Wheel Drive.
- 4WD – 4 Wheel Drive.
- PSA – Transmission Fluid Pressure Switch Assembly.
- TTS – Transmission Temperature Sensor

TRANSMISSION GENERAL DESCRIPTION

The HYDRA-MATIC 4L60-E is a fully automatic rear wheel drive electronically controlled transmission. It provides four forward ranges including overdrive, and reverse. Shift points are controlled by the PCM via two shift solenoids. Oil pressure is supplied by a vane type oil pump, and regulated by the PCM with a transmission pressure control solenoid (force motor). Shift schedules and TCC apply rates are also controlled by the PCM and are influenced by transmission temperature.

The transmission can be operated in any one of the following seven modes:

P – Park position prevents the vehicle from rolling either forward or backward. (For safety reasons the parking brake should be used in addition to the park position.)

R – Reverse allows the vehicle to be operated in a rearward direction.

N – Neutral allows the engine to be started and operated while driving the vehicle. If necessary this position may be selected if the engine must be restarted with the vehicle moving.

D – Overdrive is used for all normal driving conditions. It provides four gear ratios plus converter clutch operation. Downshifts are available for safe passing by depressing the accelerator.

D – Drive position is used for city traffic and hilly terrain. It provides three gear ranges. Again, downshifts are available by depressing the accelerator.

2 – Manual second is used to provide acceleration, engine braking, or greater traction from a stop. When manual second is chosen, the vehicle will start out and remain in second gear. This range may be selected at any vehicle speed.

1 – Manual Lo is used to provide maximum engine braking. This range may also be selected at any vehicle speed.

TRANSMISSION COMPONENT AND SYSTEM DESCRIPTIONS

The mechanical components of this unit are:

- Torque converter with converter clutch (TCC)
- Vane type oil pump
- Five multiple disc clutches
- 2-4 band assembly
- Two planetary gear sets
- One sprag clutch
- One roller clutch
- Control valve assembly

The electrical components of this unit are:

- Two shift solenoids
- 3-2 downshift solenoid
- Transmission pressure control solenoid (force motor)
- Torque converter clutch solenoid and wiring harness assembly
- Transmission fluid temperature sensor
- Fluid pressure switch assembly
- Vehicle speed sensor (2WD only)

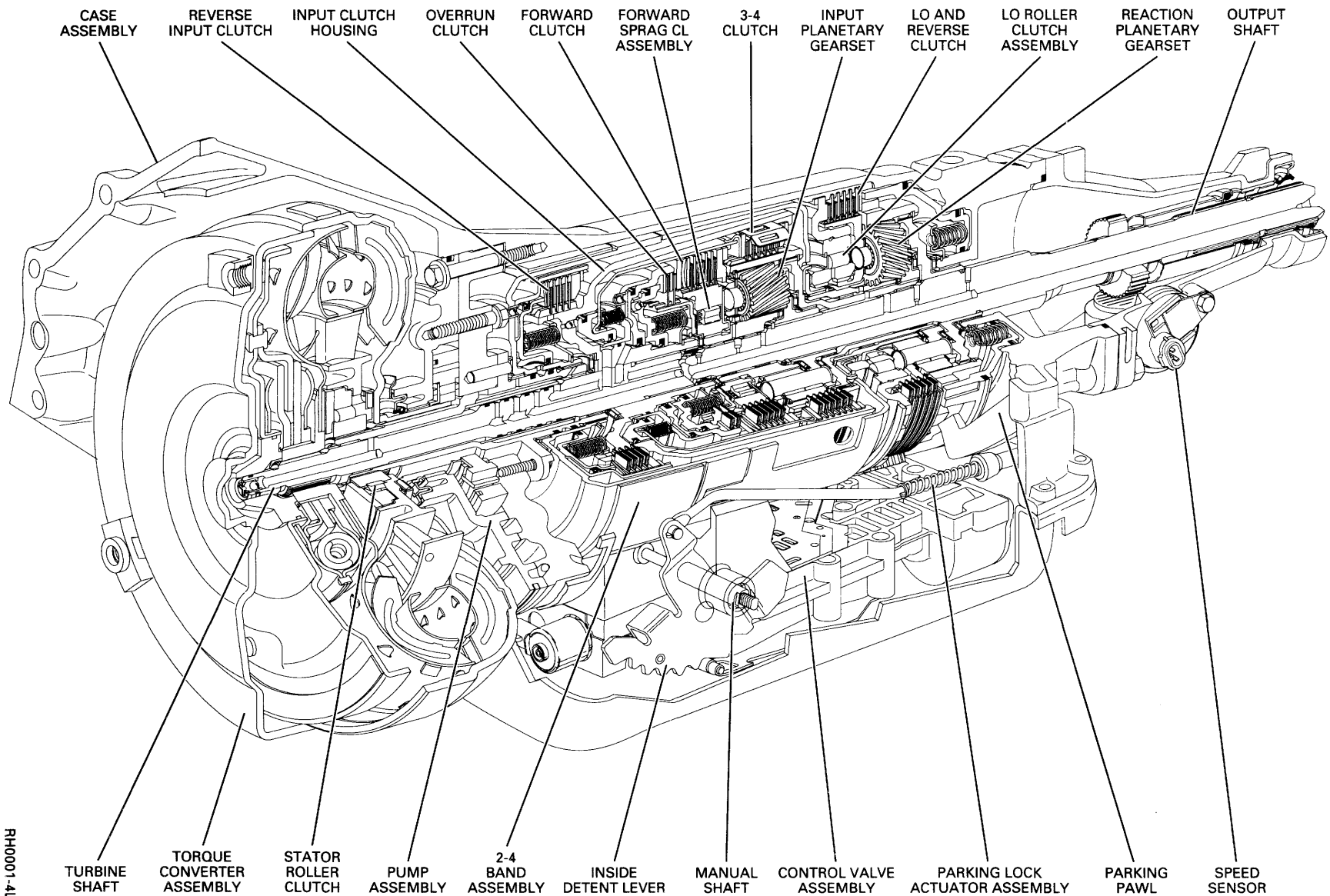
Refer to Figure 1 for component locations. Refer to Range Reference Chart Figure 7 for component operation in all seven modes of transmission operation. Refer to Figures 2-6 for detailed descriptions of electrical components.

Transmission Adapt Function

The HYDRA-MATIC 4L60-E uses a line pressure control system which has the ability to adapt the system's line pressure to compensate for normal wear of clutch fiber plates, seals, springs, etc. This "learning" feature is similar to what is used for fuel control (integrator/block learn).

The HYDRA-MATIC 4L60-E transmission only uses the adapt function for the 1-2 upshift. The PCM monitors engine speed to determine if the shift is occurring too fast (harsh) or too slow (soft) and adjusts the pressure control solenoid to maintain the correct shift feel. The line pressure can adapt to values ranging from 5 psi below, to 10 psi above normal line pressure.

HYDRA-MATIC 4L60-E



RH0001-4L60-E

Figure 1 HYDRA-MATIC 4L60-E Transmission

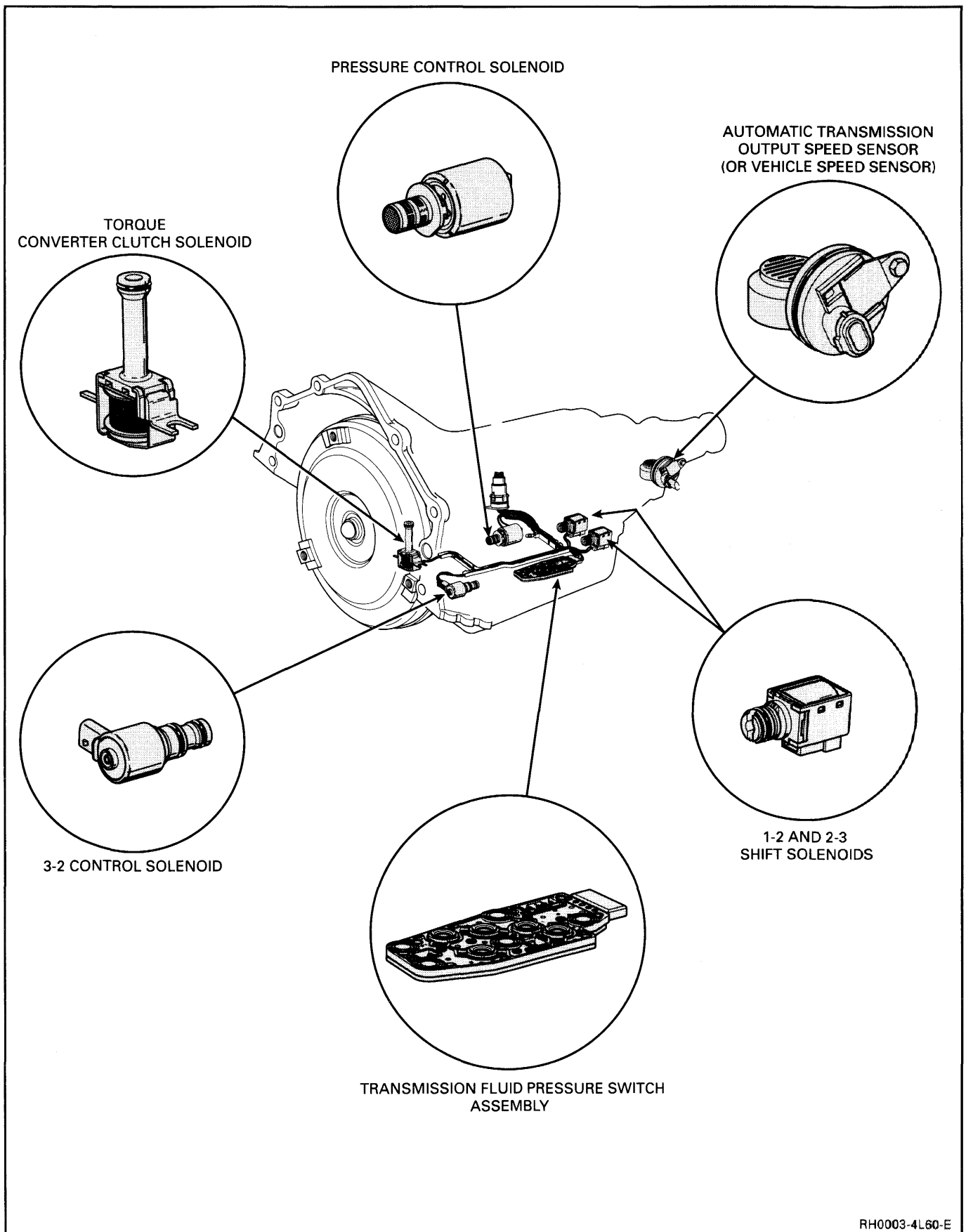


Figure 2 Electronic Component Location Views

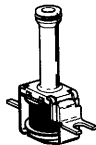
Torque Converter Clutch Solenoid

The torque converter clutch solenoid is a normally open exhaust valve that is used to control torque converter clutch apply and release.

When grounded (energized) by the PCM, the TCC solenoid stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and shift the TCC valve to shift into the apply position.

The brake switch is an input to the PCM, and the PCM directly controls TCC apply based on the brake switch status.

If a fault is detected in the TCC circuit, code 067 or 069 will set.



TCC solenoid resistance should be 20-40 ohms minimum when measured at 20°C (68°F).

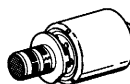
Transmission Pressure Control Solenoid

The transmission pressure control solenoid (or force motor) is an electronic pressure regulator that controls pressure based on current flow through its coil winding. The magnetic field produced by the coil moves the solenoid's internal valve which varies pressure to the pressure regulator valve.

The PCM controls the pressure control solenoid by commanding current between 0 and 1.1 amps. This changes the duty cycle of the solenoid, which can range between 0 % and 60 %. 1.1 amps corresponds to minimum line pressure, and 0 amps is maximum line pressure (if solenoid loses power, transmission will still have maximum line pressure).

Line pressure values are calculated by the PCM using inputs such as the throttle position sensor.

The pressure control solenoid takes the place of the throttle valve that was used on past model transmissions.



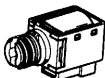
If there is a difference between the amperage commanded by the PCM and the actual amperage, diagnostic trouble code 073 will set.

Unlike the pressure control solenoid on the HYDRA-MATIC 4L80-E, the 4L60-E pressure control solenoid does not pulse every 10 seconds for a cleaning cycle.

<u>Force High</u>	<u>Force Low</u>	<u>Line Pressure</u>
+ 0% Duty Cycle	0 Amps	Maximum
+ 60% Duty Cycle	1.1 Amps @ 4-5 V	Minimum

Transmission Pressure Control Solenoid resistance should measure 3.5 - 8 ohm when measured at 20°C (68°F).

1-2 and 2-3 Shift Solenoids



The 1-2 and 2-3 shift solenoids (also called A and B solenoids) are identical solenoid devices that control the movement of the 1-2 and 2-3 shift valves (the 3-4 shift valve is not directly controlled by a shift solenoid). The solenoids are normally open exhaust valves that work in four combinations to shift the transmission into different gears (see chart).

The PCM energizes each solenoid by grounding it through an internal quad driver. This sends current through the coil winding in the solenoid and moves the internal plunger out of the exhaust position. When 'ON', the solenoid redirects fluid to move a shift valve.

PCM controlled shift solenoids eliminate the need for TV and governor pressures to control shift valve operation.

Note: The manual valve can hydraulically override the shift solenoids. Only in D4 are the shift solenoid states totally determining what gear the transmission is in. In the other manual valve positions, the transmission shifts hydraulically and the shift

solenoid states 'catch up' when throttle position and vehicle speed fall into the correct ranges.

Diagnostic trouble codes 081 and 082 indicate shift solenoid circuit voltage faults.

Shift solenoid resistance should measure 20-40 ohms minimum when measured at 20°C (68°F). Shift solenoid current flow should not exceed 0.75 amps. The shift solenoid should energize at a voltage of 7.5 volts or more (measured across the terminals). The shift solenoid should de-energize when voltage is one volt or less.

If both solenoids lose power, third gear only will result.

RH0004-4L60-E

Figure 3 Electronic Component Descriptions

Transmission Fluid Pressure Switch Assembly



The transmission fluid pressure switch assembly (PSA) is a set of five pressure switches on the valve body that sense whether fluid pressure is present in five different valve body passages. The combination of which switches are open and closed is used by the PCM to determine actual manual valve position. The PSA assembly however cannot distinguish between Park and Neutral because the monitored valve body pressures are identical in both cases.

The switches are wired to provide three signal lines that are monitored by the PCM. These inputs are used to help control line pressure, torque converter clutch apply and shift solenoid operation. Voltage at each of the signal lines will be either zero or twelve volts.

To monitor PSA assembly operation, the PCM compares the actual voltage combination of the switches to a PSA combination chart stored in its memory. If the PCM sees one of two 'illegal' voltage combinations (see chart) a code 028 will result.

PSA assembly signal voltage can be measured from each pin to ground, and compared to the combination chart. On the transmission wiring harness, pin N is 'range signal A', pin R is 'range signal B', and pin P is 'range signal C'. With the wiring harness connected and engine running, a voltage measurement of these three lines will indicate a 'high' reading (near 12 volts) when a circuit is open, and a low (zero volts) when the circuit is switched to ground.

The transmission temperature sensor is part of the transmission fluid pressure switch assembly.

Seven valid combination and two invalid combinations are available from the TPS: Valid combinations for Circuits A, B and C are shown below. Invalid combinations are A=0V, B=0V AND C=0V; OR A=0V, B=12V AND C=0V.

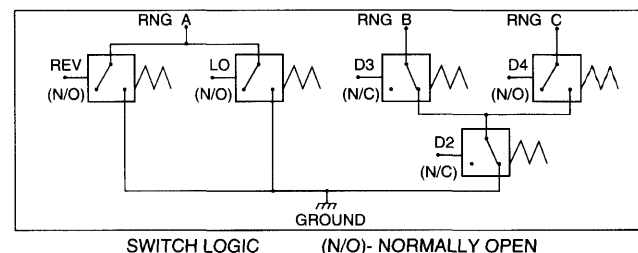
RANGE INDICATOR	OIL PRESSURE				
	REV	D4	D3	D2	LO
PARK					
REVERSE					
NEUTRAL					
D4					
D3					
D2					
D1					

■ OIL PRESSURE PRESENT

VALID TPS COMBINATION CHART

	"A"	"B"	"C"
PARK	12	0	12
REVERSE	0	0	12
NEUTRAL	12	0	12
D4	12	0	0
D3	12	12	0
D2	12	12	12
D1	0	12	12
ILLEGAL	0	12	0
ILLEGAL	0	0	0

EXPECTED VOLTAGE READINGS



Vehicle Speed Sensor



The vehicle speed sensor (or transmission output speed sensor) is used to control shift points and calculate TCC slip.

The speed sensor contains a coil that gives off a continuous magnetic field. A rotor rotates past the sensor, and the rotor teeth break the magnetic field. Each break in the field sends a pulse to the VSSB (Vehicle Speed Sensor Buffer). The VSSB sends two signals to the PCM, the first is a 2002 pulse per mile (PPM) signal used by the engine. The second is the transmission/transfer case 40 pulse per revolution (PPR) signal used to control the transmission.

In two wheel drive (2WD) applications, the vehicle speed sensor is located on the transmission extension housing.

Sensor resistance should be 1260-1540 ohms when measured at 20°C (68°F). Output voltage will vary with speed from a minimum of 0.5 Volts AC at 100 RPM, to more than 100 Volts AC at 8000 RPM.

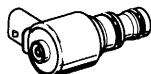
Four wheel drive (4WD) applications use a vehicle speed sensor located on the transfer case.

In 2WD or 4WD Hi, trans output speed = transfer case speed

In 4WD Lo, trans output speed = transfer case speed x constant

Codes 024 or 072 will set if a fault exists in the vehicle speed sensor circuit 40 PPR line.

3-2 Control Solenoid



The 3-2 control solenoid is a pulse width modulated solenoid used to improve the 3-2 downshift. The solenoid regulates the release of the 3-4 clutch and 2-4 band apply.

The solenoid uses duty cycle to regulate pressures that smoothly release the clutch and apply the band. Duty cycle is normally about 0% in first gear, 90% in all other drive gears and drops during the 3-2 downshift. Throttle position, vehicle speed and the commanded gear are used to determine duty cycle.

3-2 Control solenoid resistance should be a minimum of 9-14 ohms at 20°C (68°F). It is operated using pulse width modulation at a frequency of 50 Hz.

If a voltage fault is detected in the 3-2 control solenoid circuit, diagnostic trouble code 066 will set.

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Figure 4 Electronic Component Descriptions

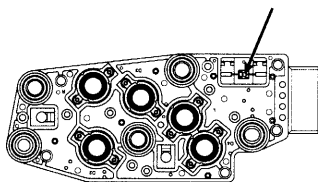
Transmission Fluid Temperature Sensor

The transmission fluid temperature sensor is part of the transmission fluid pressure switch assembly and is used to help control torque converter clutch apply and shift quality.

The temperature sensor is a resistor (thermister) which changes value based on temperature. At low temperatures the resistance is high, and at high temperatures the resistance is low.

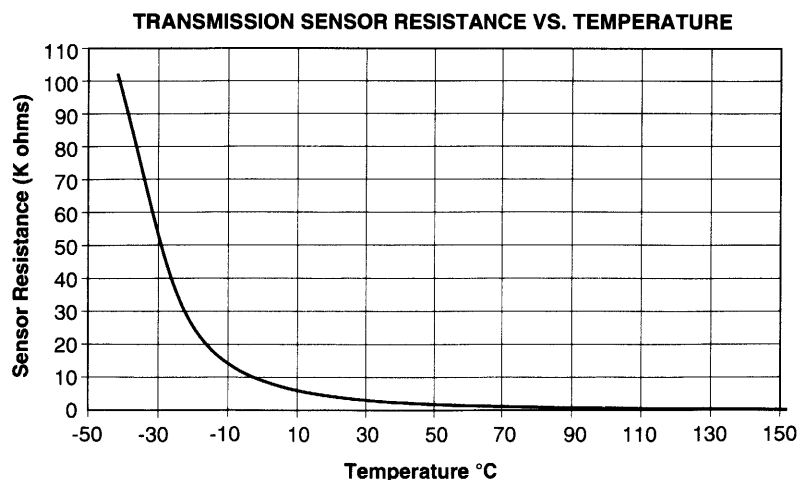
The PCM sends a 5 volt signal to the temperature sensor and measures the voltage drop in the circuit. This means you will measure a high voltage when the transmission is cold, and a low voltage when the transmission is hot.

If the temperature sensor circuit has a fault, code 058 or 059 will set. Code 079 will set if the transmission is operating at a high temperature for a period of time.



TRANSMISSION SENSOR – TEMPERATURE TO RESISTANCE TO VOLTAGE (approximate)

°C	°F	RESISTANCE	VOLTS
-40	-40	100544	5
-28	-21	52426	4.78
-16	10	18580	4.18
-4	23	12300	3.84
0	32	9379	3.45
7	40	7270	3.20
19	68	3520	2.56
31	86	2232	1.80
43	110	1200	1.10
55	131	858	3.25
67	145	675	2.88
79	176	333	2.24
91	194	241	1.70
103	213	154	1.28
115	239	115	.96
127	260	79	.64
139	284	60	.32
151	302	47	.00



RH0006-4L60-E

Figure 5 Electronic Component DescriptionsWiring Diagram

TRANSMISSION ELECTRICAL CONNECTOR

The transmission electrical connector is a very important part of the HYDRA-MATIC 4L60-E operating system. Anything that interferes with the electrical connection can cause the transmission to set Diagnostic Trouble Codes and/or operate incorrectly.

The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped (in either the transmission or vehicle wiring harness)
- Dirt contamination entering the connector when it is unconnected
- Pins in the connector backing out of the connector or pushed out during connection
- Excessive transmission fluid leaking into the connector, wicking up into the vehicle wiring harness and degrading the wire insulation *
- Water/moisture intrusion in the connector
- Low pin retention from excessive connection and disconnection of the wiring harness
- Pin corrosion from contamination

* The presence of transmission fluid in the transmission connector is not harmful in itself. The fluid only affects the vehicle harness wiring insulation if the fluid wicks up that far.

Points to remember when working with the transmission electrical connector:

- To remove the connector, squeeze the two tabs towards each other and pull straight up (See illustration).
- Carefully limit twisting or wiggling the connector during removal. This can bend pins.
- DO NOT pry the connector off with a screwdriver or other tool.
- To install the connector, first orient the pins by lining up the arrows on each half of the connector. Push the connector straight down into the transmission without twisting or angling the mating parts.
- The connector should click into place with a positive feel and/or noise.
- Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple Diagnostic Trouble Codes will set. Be sure to clear these codes after re-connecting the pass-thru connector.

DTC's 59, 67 and 82 will set with key on, engine off.

DTC's 59, 66, 67, 73 and 82 will set with key on, engine on.

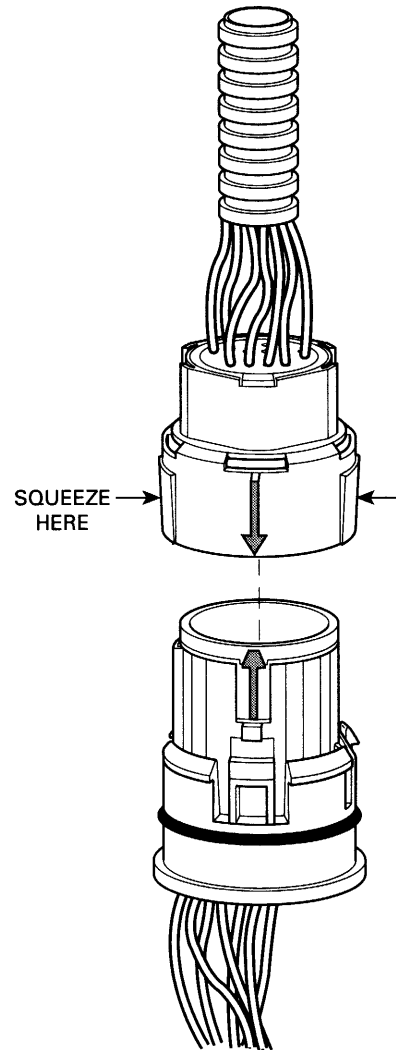
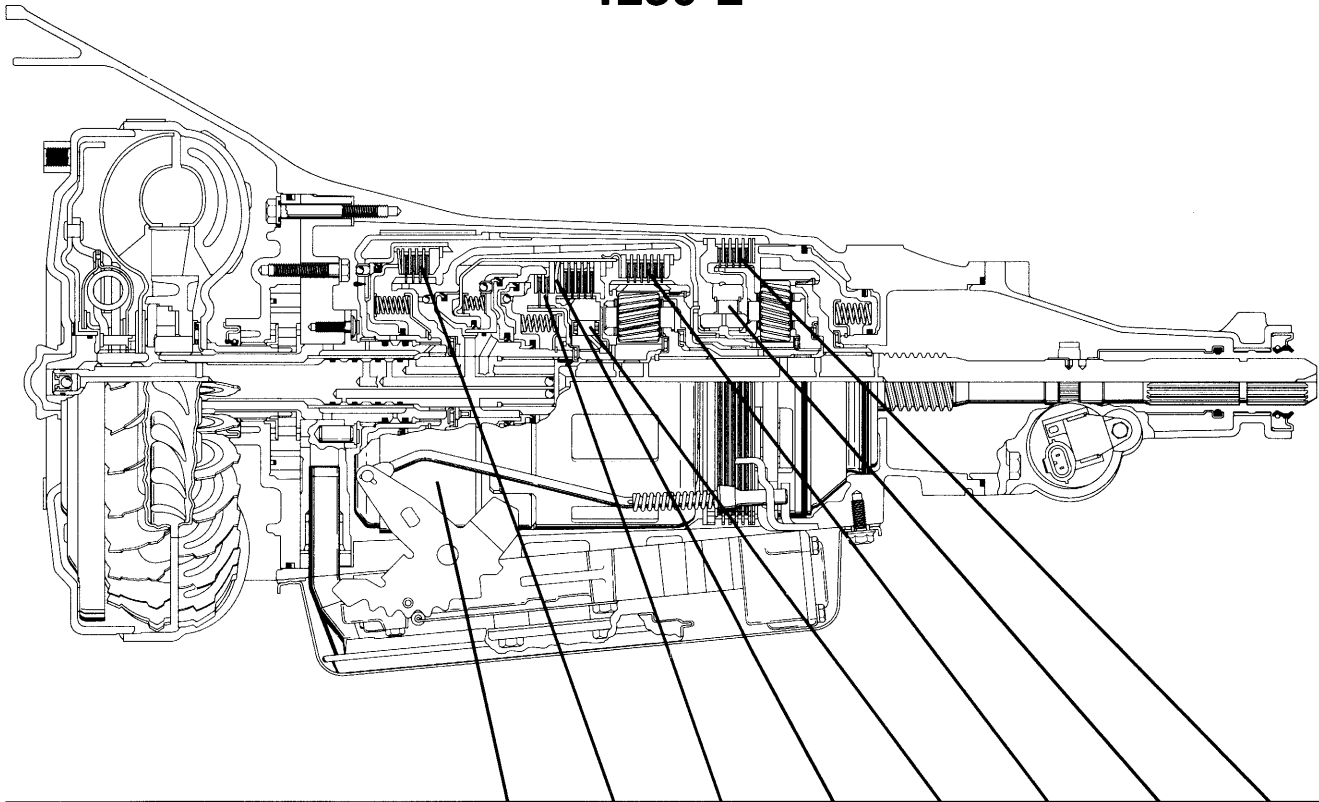


Figure 6 Transmission Electrical Connector

4L60-E



RANGE	GEAR	SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
		1-2	2-3								
PARK		ON*	ON*								APPLIED
REVERSE		ON*	ON*		APPLIED						APPLIED
NEUTRAL		ON*	ON*								
D	1st	ON	ON				APPLIED	HOLDING		HOLDING	
	2nd	OFF	ON	APPLIED			APPLIED	HOLDING			
	3rd	OFF	OFF				APPLIED	HOLDING	APPLIED		
	4th	ON	OFF	APPLIED			APPLIED		APPLIED		
D	1st	ON	ON				APPLIED	HOLDING		HOLDING	
	2nd	OFF	ON	APPLIED			APPLIED	HOLDING			
	3rd	OFF	OFF			APPLIED	APPLIED	HOLDING	APPLIED		
2	1st**	ON	ON			APPLIED	APPLIED	HOLDING		HOLDING	
	2nd	OFF	ON	APPLIED		APPLIED	APPLIED	HOLDING			
1	1st	ON	ON			APPLIED	APPLIED	HOLDING		HOLDING	APPLIED
	2nd***	OFF	ON	APPLIED		APPLIED	APPLIED	HOLDING			

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

** MANUAL SECOND – FIRST GEAR IS ELECTRONICALLY PREVENTED UNDER NORMAL OPERATING CONDITIONS.

*** MANUAL FIRST – SECOND GEAR IS ONLY AVAILABLE ABOVE APPROXIMATELY 48 TO 56 KM/H (30 TO 35 MPH).

PH0002-4L60-E-R1

Figure 7 Range Reference Chart

DIAGNOSIS

NOTICE: If a wire is probed with a sharp instrument and not properly sealed afterward, the wire will corrode and an open circuit will result.

Diagnostic test probes are now available that allow you to probe individual wires without leaving the wire open to the environment. These probe devices are inexpensive and easy to install, and they permanently seal the wire from corrosion.

BASIC KNOWLEDGE REQUIRED (Refer to 6E)

You must be familiar with some basic electronics to use this section of the Service Manual. They will help you to follow diagnostic procedures.

NOTICE: Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in incorrect diagnostic performance or damage to powertrain components. Do not, under any circumstances, attempt to diagnose a powertrain problem without this basic knowledge.

Special Tools

You should be able to use a Digital Volt Meter (DVM), a circuit tester, jumper wires or leads and a line pressure gage set. The functional test procedures given in Figures 8 and 9 are designed to verify the correct operation of electronic components in the transmission. This will eliminate the unnecessary removal of transmission components.

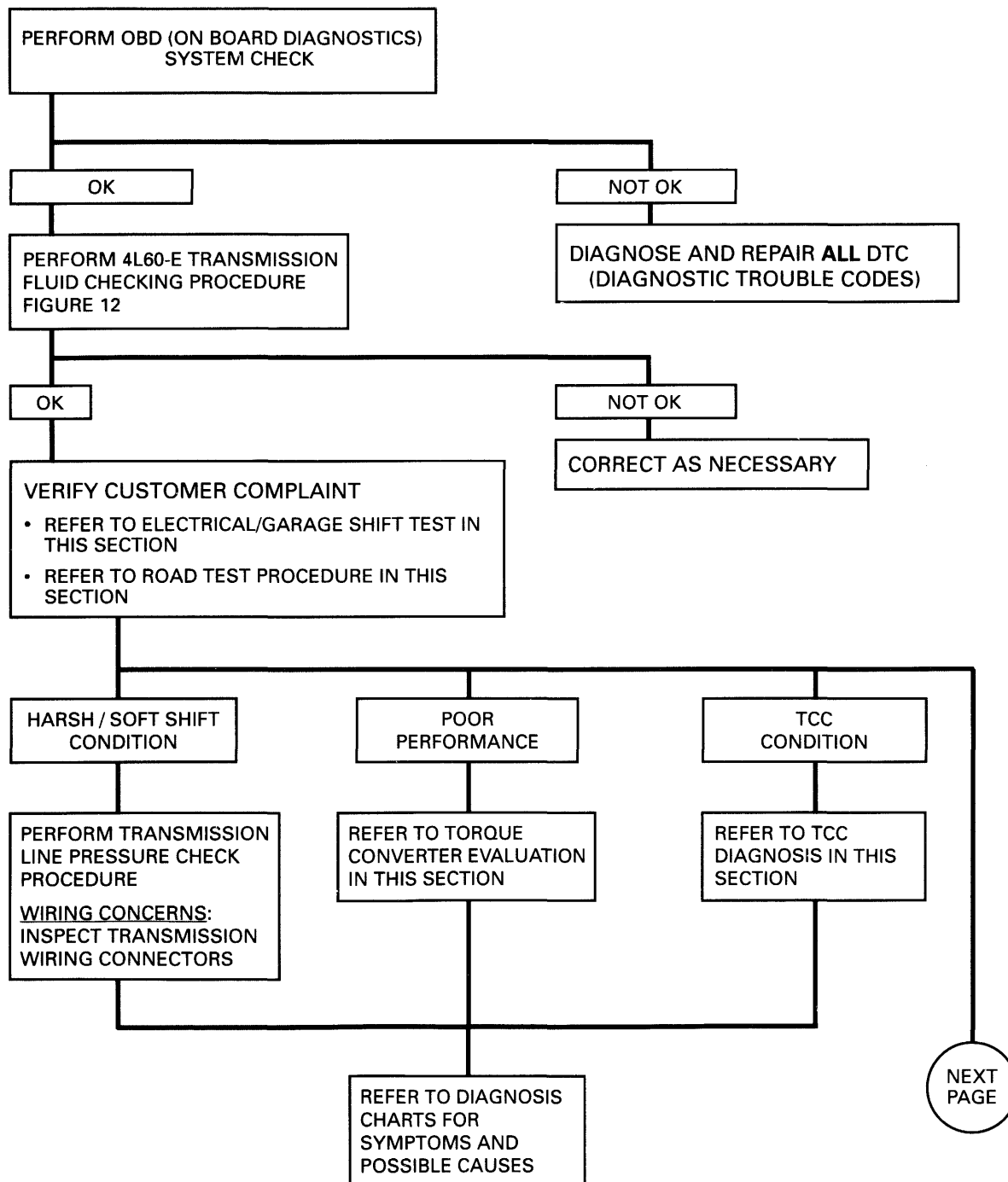
QUICK CHECK PROCEDURE

When diagnosing any HYDRA-MATIC 4L60-E related condition, always begin with the functional test procedure in this section. The functional test procedure will indicate the proper path of diagnosing the transmission by describing the basic checks and then referencing the locations of specific checks. Refer to Figures 8 and 9.

TRANSMISSION FLUID CHECKING PROCEDURE

Whenever checking HYDRA-MATIC 4L60-E transmission fluid refer to Figure 12.

**4L60-E TRANSMISSION
FUNCTIONAL TEST (1 of 2)**



RH0011-4L60-E

Figure 8 Transmission Functional Test (1 of 2)

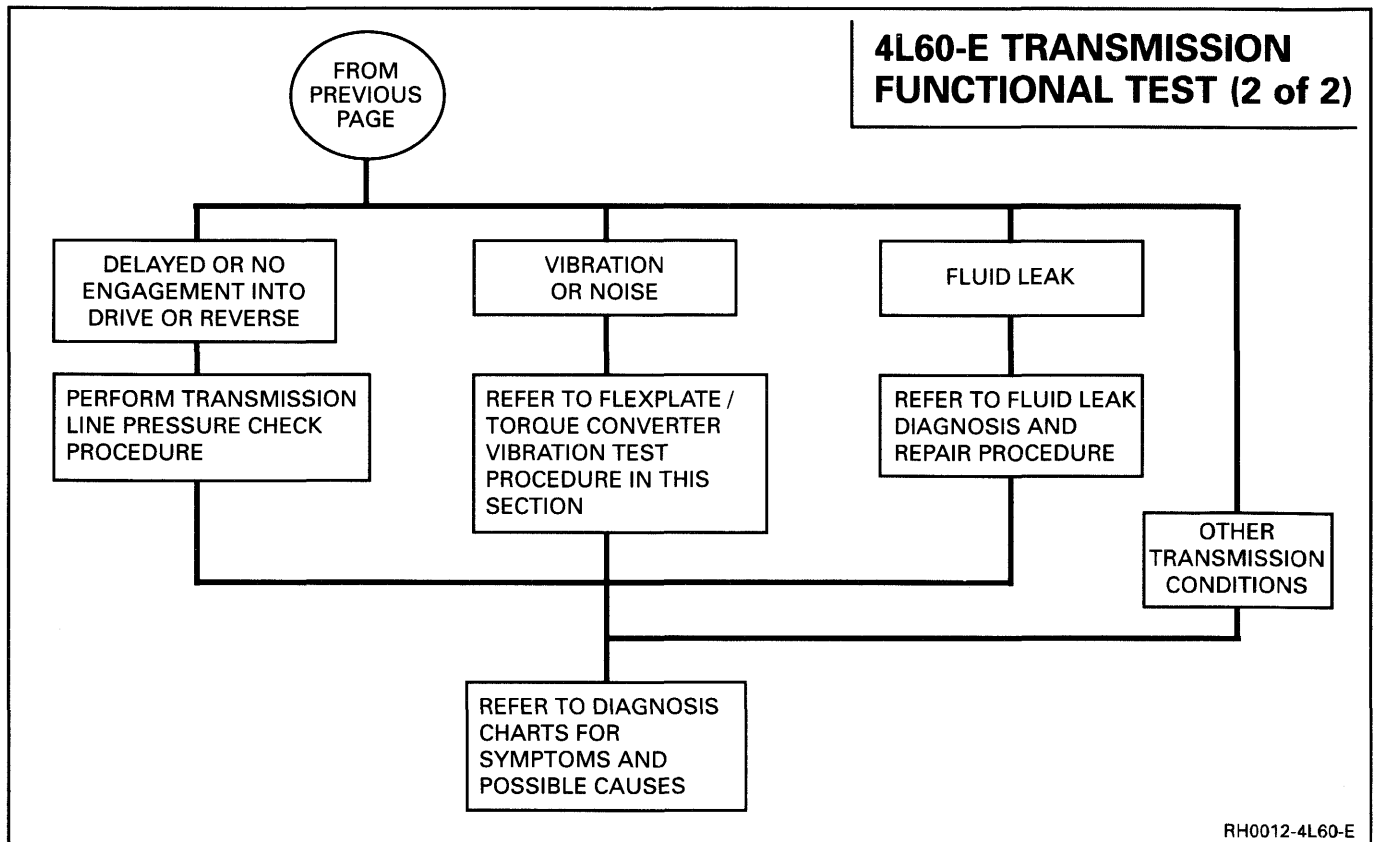


Figure 9 Transmission Functional Test (2 of 2)

DIAGNOSTIC TROUBLE CODES AND DEFAULT ACTIONS**Refer to the Driveability and Emissions Electrical Diagnosis Manual**

TROUBLE CODE	CODE PARAMETERS	DEFAULT ACTION
14 Engine Coolant Temp Sensor Circuit (High)	Engine coolant temp over 151°C (306°F) for 1/2 second.	• TCC apply cold.
15 Engine Coolant Temp Sensor Circuit (Low)	Engine coolant temp less than -40°C (-40°F) for 1/2 second.	• TCC apply cold.
21 Throttle Position Sensor Circuit (High)	TP voltage greater than 4.88 volts for four seconds.	• No TCC. • Fixed shift points. • Harsh shifts. • Maximum line pressure. • No fourth gear in hot mode.
22 Throttle Position Sensor Circuit (Low)	With engine running, TP voltage less than .06 volts for four seconds. (Diesel is less than .16 volts.)	• No TCC. • Fixed shift points. • Harsh shifts. • Maximum line pressure. • No fourth gear in hot mode.
24 Vehicle Speed Sensor Signal Low	In Drive or Reverse with engine speed greater than 3000 rpm, output speed is less than 250 rpm for three seconds. (MAP is 100-255 kPa, TP is 10-100%)	• Maximum line pressure. • Second gear only.
28 Fluid Pressure Switch Assembly Fault	PCM detects one of two "invalid" combinations of PSM signals for five seconds.	• No TCC. • Harsh shifts. • No fourth gear in hot mode. • No 2nd gear in D2.
37 Brake Switch Stuck "ON"	With brake on, vehicle speed is 5-20 mph for six seconds, then vehicle speed is >20 mph for six seconds. After vehicle speed is < 5 mph. This must happen seven times.	• No TCC. • No fourth gear in hot mode.
38 Brake Switch Stuck "OFF"	With brake off, vehicle speed is >20 mph for six seconds, then vehicle speed is 5-20 mph for six seconds. After vehicle speed is < 5 mph. This must happen seven times.	• No TCC. • No fourth gear in hot mode.
52 Long System Voltage High	Generator voltage is greater than 16 volts for 109 minutes.	• No TCC. • Maximum line pressure. • Third gear only.
53 System Voltage High	Generator voltage is greater than 19.5 volts for two seconds.	• No TCC. • Maximum line pressure. • Third gear only.
58 Transmission Fluid Temp Sensor Circuit (High)	Transmission fluid temperature is greater than 151°C (306°F) for one second.	• No default action.
59 Transmission Fluid Temp Sensor Circuit (Low)	Transmission fluid temperature is below -40°C (-40°F) for one second.	• No default action.

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Figure 10 Trouble Chart Diagnosis Chart A

DIAGNOSTIC TROUBLE CODES AND DEFAULT ACTIONS**Refer to the Driveability and Emissions Electrical Diagnosis Manual**

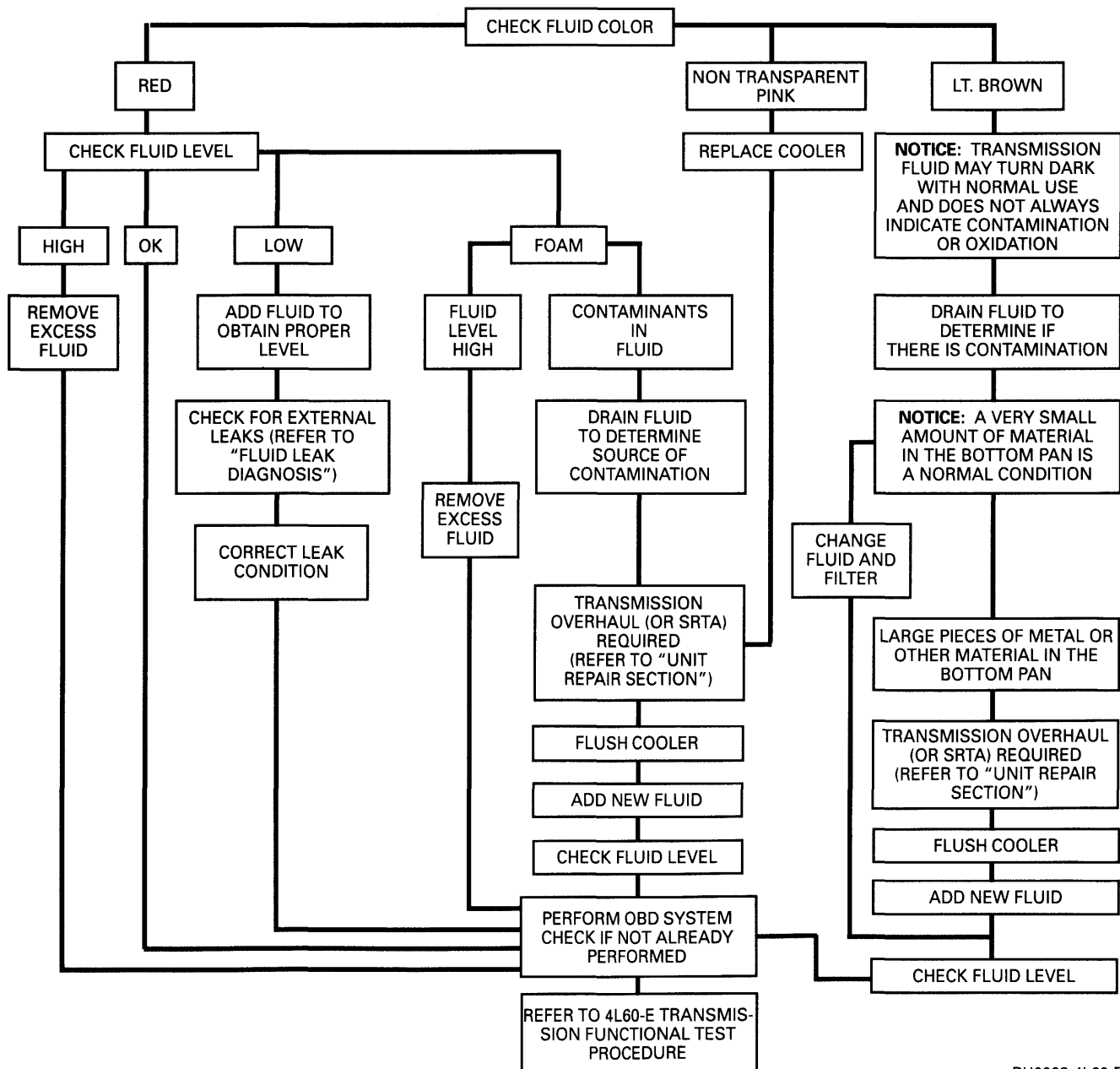
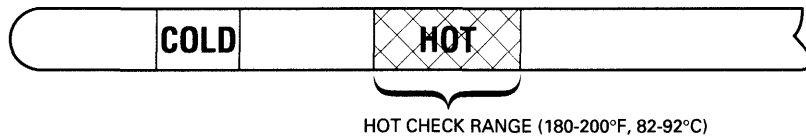
TROUBLE CODE	CODE PARAMETERS	DEFAULT ACTION
66 3-2 Control Solenoid Circuit Fault	At high duty cycle, the circuit voltage high -OR- at low duty cycle the circuit voltage is low for four seconds.	• Third gear only • Soft landing to 3rd gear
67 TCC Solenoid Circuit Fault	TCC is commanded on, but circuit is high -OR- TCC is commanded off but circuit voltage is low for two seconds.	• No TCC. • No fourth gear in hot mode.
69 TCC Stuck "ON"	With gear selector in a drive range, transmission in 2nd, 3rd or 4th, TP Sensor greater than 25% and TCC unlocked - slip is between -20 and 20 RPM.	• TCC "ON" in all gears. • Early shifts.
72 Vehicle Speed Sensor Loss	Two successive speed readings have a difference of more than 1000 RPM. (Difference must be more than 1500 RPM in P and N.)	• Maximum line pressure. • Soft landing second gear only. • No TCC.
73 Pressure Control Solenoid Current	Pressure control solenoid return amperage varies more than .16 amp from commanded amperage for one second.	• Harsh shifts. • Maximum line pressure.
75 System Voltage Low	System voltage is less than 7.3 V at low temps and less than 11.7 V at high temps for four seconds.	• No TCC. • Maximum line pressure. • Third gear only.
79 Transmission Fluid Overtemp	Transmission temp is higher than 146°C (302°F) for 30 minutes.	
81 2-3 Shift Solenoid Circuit Fault	2-3 Shift Solenoid is commanded "ON" by PCM but circuit voltage is high for two seconds OR 2-3 Shift Solenoid is commanded "OFF" by PCM but circuit voltage is low for two seconds.	• No TCC • Maximum line pressure. • Second or third gear only.
82 1-2 Shift Solenoid Circuit Fault	1-2 Shift Solenoid is commanded "ON" by PCM but circuit voltage is high for two seconds OR 1-2 Shift Solenoid is commanded "OFF" by PCM but circuit voltage is low for two seconds.	• Maximum line pressure. • Second or third gear only - OR • First and fourth gears only.

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Figure 11 Trouble Code Diagnosis Chart B

4L60-E TRANSMISSION FLUID CHECKING PROCEDURE

1. Warm the transmission to operating temperature by driving the vehicle about 15 miles (24 km). Operating temperature is 180-200°F (82-94°C).
 2. Park vehicle on a level surface, place shift lever in "P" park and apply the parking brake.
 3. Check fluid level on the dipstick (read the lower level).
 4. If fluid level is low, add only enough DEXRON®-IIE to bring the fluid level into the hot area.
- * It is important to check fluid level when the transmission has reached operating temperature. The hot range is calibrated to correspond to the correct fluid level range for fluid between 180 and 200°F (82-94°C).



RH0008-4L60-E

Figure 12 Fluid Checking Procedure

HYDRA-MATIC 4L60-E LINE PRESSURE CHECK PROCEDURE

Line pressures are calibrated for two sets of gear ranges – Drive-Park-Neutral and Reverse. This allows the transmission line pressure to be appropriate for different pressure needs in different gear ranges:

<u>Gear Range</u>	<u>Line Pressure Range</u>
Drive, Park or Neutral	55 - 189 PSI
Reverse	64 - 324 PSI

Before performing a line pressure check, verify that the pressure control solenoid is receiving the correct electrical signal from the PCM:

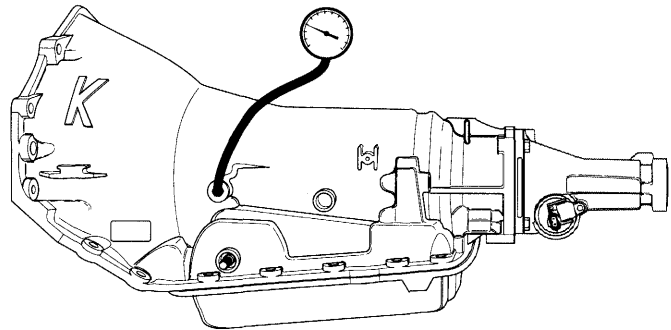
1. Install a scan tool.
2. Start the engine and set parking brake.
3. Check for a stored pressure control solenoid diagnostic trouble code, and other diagnostic trouble codes.
4. Repair vehicle if necessary.

Inspect

- Fluid level (see Section 7A)
- Manual linkage

Install or Connect

- TECH 1 Scan tool
- Oil pressure gage at line pressure tap



5. Put gear selector in Park and set the parking brake.
6. Start engine and allow it to warm up at idle.
7. Access the "PCS Control" test on the TECH 1 scan tool.
8. Increase DESIRED PCS in 0.1 Amp increments and read the corresponding line pressure on the pressure gage. (Allow pressure to stabilize for 5 seconds after each current change.)
9. Compare data to the Drive-Park-Neutral line pressure chart below.

*NOTICE

Total test running time should not exceed 2 minutes, or transmission damage could occur.

CAUTION

Brakes must be applied at all times to prevent unexpected vehicle motion.

If pressure readings differ greatly from the line pressure chart, refer to the Diagnosis Charts contained in this section.

The TECH 1 scan tool is only able to control the pressure control solenoid in Park and Neutral with the vehicle stopped. This protects the clutches from extremely high or low pressures in Drive or Reverse ranges.

Pressure Control Solenoid Current (Amp)	Line Pressure (PSI)
0.02	170 - 190
0.10	165 - 185
0.20	160 - 180
0.30	155 - 175
0.40	148 - 168
0.50	140 - 160
0.60	130 - 145
0.70	110 - 130
0.80	90 - 115
0.90	65 - 90
0.98	55 - 65

Pressures at 1500 RPM and 66°C (150°F). Line pressure drops as temperature increases.

PH0010-4L60-E-R1

Figure 13 Line Pressure Check Procedure

LINE PRESSURE CHECK PROCEDURE

This test can be performed during the hoist or road test. It is easier to check pressures during the hoist test because the tubing and pressure gage can remain outside of the vehicle, and won't be damaged by road conditions or debris. The technician can diagnose more quickly on the hoist since the driver doesn't have to watch the road.

The HYDRA-MATIC 4L60-E uses a vane type oil pump to produce hydraulic pressure, and a transmission pressure control solenoid (force motor) to control that pressure at the pressure regulator valve, after it leaves the pump. The transmission pressure control solenoid is controlled by an electrical signal that ranges from 0 to 1 amp. One amp corresponds to minimum line pressure (approx. 50 to 55 PSI not 0 PSI) and 0 amps corresponds to a maximum line pressure (approx. 265 to 290 PSI) in D. Refer to Figure 13 to perform line pressure test.

ELECTRICAL/GARAGE SHIFT TEST

This preliminary test should be performed before a hoist or road test to make sure electronic control inputs are connected and operating. If the inputs are not checked before operating the transmission, a simple electrical condition could be misdiagnosed as a major transmission condition.

A scan tool provides valuable information and must be used on the HYDRA-MATIC 4L60-E transmission for accurate diagnosis. Refer to Figure 15 for an example of Tech 1 information.

1. Move gear selector to "Park" (P) and set the parking brake.
2. Connect scan tool to DLC terminal.
3. Start engine.
4. Connect power to scan tool.
5. Verify that the following signals are present:
 - ENGINE SPEED
 - TRANS OUTPUT SPEED
 - VEHICLE SPEED
 - A/B/C RNG
 - PRNDL SELECT
 - DESIRED PCS
 - ACTUAL PCS
 - PCS DUTY CYCLE
 - BRAKE SWITCH
 - 4 WD LOW SWITCH (4WD Only)
 - ENG COOLANT TEMP
 - TRANS FLUID TEMP
 - THROTTLE ANGLE
 - SYSTEM VOLTS

6. Monitor the BRAKE SWITCH signal while tapping the brake pedal with your foot.
 - The BRAKE SWITCH should be on when the pedal is depressed, and come off when the brake pedal is released.
7. Monitor the PRNDL SELECT signal and move the gear selector through all the ranges.
 - Verify that the PRNDL SELECT value matches the gear range indicated on the instrument panel or console.
 - Gear selections should be immediate and not harsh.
8. Move gear selector to neutral and monitor the THROTTLE ANGLE signal while increasing and decreasing engine RPM with the accelerator pedal.
 - THROTTLE ANGLE should increase with engine RPM.

Upshift Control and Torque Converter Clutch (TCC) Apply

The PCM calculates upshift points based primarily on two inputs: THROTTLE ANGLE and VEHICLE SPEED. When the PCM says a shift should occur, an electrical signal is sent to the shift solenoids which in turn moves the valves to perform the upshift.

The shift speed charts reference THROTTLE ANGLE instead of "min throttle" or "wot" to make shift speed measurement more uniform and accurate. A scan tool should be used to monitor THROTTLE ANGLE. Some scan tools have been programmed to record shift point information. Check the instruction manual to see if this test is available. Refer to Figures 16, 17, 18, 19 and 20 for examples of Tech 1 information.

With gear selector in D4:

1. Look at the shift speed chart contained in this section and choose a percent throttle angle of 15 or 20. (Figure 26.)
2. Set up the scan tool to monitor THROTTLE ANGLE and VEHICLE SPEED.
3. Accelerate to the chosen throttle angle and hold the throttle steady.
4. As the transmission upshifts, note the shift speed and commanded gear changes for:
 - 2nd gear.
 - 3rd gear.
 - 4th gear.

? Important

- Shift speeds may vary due to slight hydraulic delays responding to electronic controls. A change from the original equipment tire size also affects shift speeds.
Note when TCC applies. This should occur in third or fourth gear. If the apply is not noticed by an RPM drop, refer to the "Preliminary Torque Converter Clutch Diagnosis" information contained in this section.
The TCC should not apply unless the **transmission** has reached a minimum operating temperature of 18°C TRAN TEMP and engine coolant temp of 60°C.
- 5. Repeat steps 1-4 using several different throttle angles.

Part Throttle Detent Downshift

At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, quickly increase throttle angle.

Verify that:

- TCC releases.
- Transmission downshifts to 3rd gear immediately.
- 1-2 Shift Solenoid turns off.

Full Throttle Detent Downshift

At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, quickly increase throttle angle to its maximum position. Refer to Figures 22, 23, and 24 for examples of Tech 1 information.

Verify that:

- TCC releases.
- Transmission downshifts to 2nd gear immediately.
- 1-2 Shift Solenoid is off, 2-3 Shift Solenoid is on.

Manual Downshifts

The shift solenoids do not control the initial downshift during 4-3 and 3-2 manual downshifts. All manual downshifts are hydraulic except the 2-1. The solenoid states will change during, or shortly after a manual downshift is selected. Refer to Figure 24 for an example of Tech 1 information.

1. At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, release the accelerator pedal while moving the gear selector to D3. Observe that:

- TCC releases.
 - Transmission downshifts to 3rd gear immediately.
 - Engine slows vehicle down.
2. Move gear selector back to D4 and accelerate to 64 to 72 km/h (40 to 45 mph). Release the accelerator while moving the gear selector to D2 and observe that:
 - TCC releases.
 - Transmission downshifts to 2nd gear immediately.
 - Engine slows vehicle down.
 3. Move gear selector back to D4 and accelerate to 48 km/h (30 mph). Release the accelerator pedal while moving the gear selector to D1 and observe that:
 - TCC releases.
 - Transmission downshifts to 1st gear immediately.
 - Engine slows vehicle down.

Coasting Downshifts

1. With the gear selector in D4, accelerate to 4th gear with TCC applied.
2. Release the accelerator pedal and lightly apply the brakes, and observe that:
 - TCC releases.
 - Downshifts occur at speeds shown on the shift speed chart.

Manual Gear Range Selection

Upshifts in the manual gear ranges are controlled by the shift solenoids.

Perform the following tests by accelerating at 10-15 degrees TP Sensor.

Manual Third (D3)

- With vehicle stopped, move the gear selector to D3 and accelerate to observe:
 - 1-2 shift.
 - 2-3 shift.

Manual Second (D2)

1. With vehicle stopped, move gear selector to D2 and accelerate to observe:
 - Transmission starts and remains in second gear.
2. Accelerate to 40 km/h (35 mph) and observe:
 - 2-3 shift does not occur.
 - TCC does not apply.

Manual First (D1)

- With vehicle stopped, move gear selector to D1. Accelerate to 32 km/h (20 mph) and observe:
 - No upshifts occur.
 - TCC does not apply.
 - Can upshift out of first at fuel cut-off.

Reverse (R)

- With vehicle stopped, move gear selector to R and slowly accelerate to observe:
 - 1-2 and 2-3 Shift Solenoids are on.

Use a scan tool to see if any transmission trouble codes have been set. Refer to “Trouble Code Diagnosis” in this section and repair the vehicle as directed. After repairing the vehicle, perform the hoist test and verify that the code has not set again.

If the transmission is not performing well and no trouble codes have been set, there may be an intermittent condition. Check all electrical connections for damage or a loose fit. Some scan tools have a snapshot test which can help catch an intermittent condition that doesn't occur long enough to set a code.

You may want to read “Electronic Component Diagnosis” in this section to become familiar with transmission conditions caused by transmission electrical malfunctions.

If no trouble codes have been set and the condition is suspected to be hydraulic, take the vehicle on a road test.

ROAD TEST PROCEDURE

- Perform the road test using a scan tool.
 - This test should be performed when traffic and road conditions permit.
 - Observe all traffic safety regulations.
1. Start engine.
 2. Depress brake pedal.
 3. Move gear selector from:
 - Park to Reverse.
 - Reverse to Neutral.
 - Neutral to D4.

**Important**

- Gear selections should be immediate and not harsh.
4. Perform the same test procedure as instructed previously in the road test:
 - Upshifts and TCC apply.
 - Part Throttle Detent Downshift.

- Full Throttle Detent Downshift.
- Manual Downshifts.
- Coasting Downshifts.
- Manual Gear Range Selection.

Use a scan tool to see if any transmission malfunction codes have been set. If so, perform transmission functional test. (Figure 8.) After repairing the vehicle, perform the road test and verify that no codes have been set again.

If no codes have been set and the condition remains, refer to the “Diagnosis Charts” contained in this section. If the condition is suspected to originate in the torque converter, refer to “Torque Converter Clutch (TCC) Diagnosis” later in this section.

TORQUE CONVERTER CLUTCH (TCC) DIAGNOSIS

To properly diagnose the Torque Converter Clutch (TCC) system, perform all electrical testing first and then the hydraulic testing.

The TCC is applied by fluid pressure which is controlled by a solenoid located inside the Automatic Transmission assembly. The solenoid is energized by completing an electrical circuit through a combination of switches and sensors. Refer to Figure 21 for an example of Tech 1 information.

Functional Check Procedure**Inspect**

1. Install a tachometer or scan tool.
2. Operate the vehicle until proper operating temperature is reached.
3. Drive vehicle at 80 to 88 km/h (50 to 55 mph) with light throttle (road load).
4. Maintaining throttle, lightly touch the brake pedal and check for release of the TCC and a slight increase in engine speed (RPM).
5. Release the brake, slowly accelerate and check for a re-apply of the converter clutch and a slight decrease in engine speed (RPM).

TORQUE CONVERTER EVALUATION**Torque Converter Stator**

The torque converter stator roller clutch can have one of two different type **malfunctions**:

- A. Stator assembly freewheels in both directions.
- B. Stator assembly remains locked up at all times.

Condition A-Poor Acceleration Low Speed

The car tends to have poor acceleration from a standstill. At speeds above 50 to 55 km/h (30 to 35 mph), the car may act normal. If poor acceleration is noted, it should first be determined that the exhaust system is not blocked, and the transmission is in first (1st) gear when starting out.

If the engine freely accelerates to high RPM in "NEUTRAL" (N), it can be assumed that the engine and exhaust system are normal. Checking for poor performance in "Drive" and "Reverse" will help determine if the stator is freewheeling at all times.

Condition B-Poor Acceleration High Speed

Engine RPM and car speed limited or restricted at high speeds. Performance when accelerating from a standstill is normal. Engine may over-heat. Visual examination of the converter may reveal a blue color from over-heating.

If the converter has been removed, the stator roller clutch can be checked by inserting two fingers into the splined inner race of the roller clutch and trying to turn the race in both directions. The inner race should turn freely clockwise, but not turn or be very difficult to turn counterclockwise.

Noise

Torque converter whine is usually noticed when the vehicle is stopped and the transmission is in "Drive" or "Reverse". The noise will increase when engine RPM is increased. The noise will stop when the vehicle is moving or when the torque converter clutch is applied because both halves of the converter are turning at the same speed.

Perform a stall test to make sure the noise is actually coming from the converter:

1. Place foot on brake.
2. Put gear selector in "Drive".
3. Depress accelerator to approximately 1200 RPM for no more than six seconds.

NOTICE: If the accelerator is depressed for more than six seconds, damage to the transmission may occur.

A torque converter noise will increase under this load.

Important

- This noise should not be confused with pump whine noise which is usually noticeable in "Park", "Neutral" and all other gear ranges. Pump whine will vary with pressure ranges.

The torque converter should be replaced under any of the following conditions:

- External leaks in the hub weld area.
- Converter hub is scored or damaged.
- Converter pilot is broken, damaged or fits poorly into crankshaft.
- Steel particles are found after flushing the cooler and cooler lines.
- Pump is damaged or steel particles are found in the converter.
- Vehicle has TCC shudder and/or no TCC apply. Replace only after all hydraulic and electrical diagnoses have been made. (Converter clutch material may be glazed.)
- Converter has an imbalance which cannot be corrected. (Refer to Converter Vibration Test Procedure.)
- Converter is contaminated with engine coolant containing antifreeze.
- Internal failure of stator roller clutch.
- Excess end play.
- Heavy clutch debris due to overheating (blue converter).
- Steel particles or clutch lining material found in fluid filter or on magnet when no internal parts in unit are worn or damaged – indicates that lining material came from converter.

The Torque Converter Should Not Be Replaced If:

- The oil has an odor, is discolored, and there is no evidence of metal or clutch facing particles.
- The threads in one or more of the converter bolt holes are damaged.
 - Correct with thread insert. (Refer to SECTION 6A.)
- Transmission failure did not display evidence of damage or worn internal parts, steel particles or clutch plate lining material in unit and inside the fluid filter.
- Vehicle has been exposed to high mileage (only). The exception may be where the torque converter clutch damper plate lining has seen excess wear by vehicles operated in heavy and/or constant traffic, such as taxi, delivery or police use.

TCC SHUDDER

The key to diagnosing Torque Converter Clutch (TCC) shudder is to note when it happens and under what conditions.

TCC Shudder should only occur during the APPLY and/or RELEASE of the converter clutch; SELDOM after the TCC plate is fully applied.

While TCC Is Applying Or Releasing:

If the shudder occurs while TCC is applying, the problem can be within the transmission or torque converter. Something is not allowing the clutch to become fully engaged, not allowing clutch to release, or is trying to release and apply the clutch at the same time. This could be caused by leaking turbine shaft seals, a restricted release orifice, a distorted clutch or housing surface due to long converter bolts, or defective friction material on the TCC plate.

Shudder Occurs After TCC Has Applied:

In this case, most of the time there is nothing wrong with the transmission! As mentioned above, once the TCC has been applied, it is very unlikely that it will slip. Engine problems may go unnoticed under light throttle and load, but become noticeable after TCC apply when going up a hill or accelerating, due to the mechanical coupling between engine and transmission.

REMEMBER: Once TCC is applied there is no torque converter (fluid coupling) assistance. Engine or driveline vibrations could be unnoticeable before TCC engagement.

Inspect the following components to avoid misdiagnosis of TCC Shudder and possibly disassembling a transmission and/or replacing a torque converter unnecessarily:

- Spark plugs – Inspect for cracks, high resistance or broken insulator.
- Plug wires – Look in each end. If there is red dust (ozone) or black substance (carbon) present, then the wires are bad. Also look for a white discoloration of the wire indicating arcing during hard acceleration.
- Distributor cap and rotor – Look for broken or uncrimped parts.
- Coil – Look for black on bottom indication arcing while engine is misfiring.
- Fuel injector – Filter may be plugged.
- Vacuum leak – Engine won't get correct amount of fuel. May run rich or lean depending on where the leak is.
- EGR valve – Valve may let in too much unburnable exhaust gas and cause engine to run lean.
- MAP/MAF sensor – Like vacuum leak, engine won't get correct amount of fuel for proper engine operation.
- Carbon on intake valves – Restricts proper flow or air/fuel mixture into cylinders.
- Flat cam – Valves don't open enough to let proper fuel/air mixture into cylinders.

- Oxygen sensor – May command engine too rich or too lean for too long.
- Fuel pressure – May be too low.
- Engine mounts – Vibration of mounts can be multiplied by TCC engagement.
- Axle joints – Check for vibration.
- TPS – TCC apply and release depends on TPS in many engines. If TPS is out of specification, TCC may remain applied during initial engine crowd.
- Cylinder balance – Bad piston rings or poorly sealing valves can cause low power in a cylinder.
- Fuel contamination – Causes poor engine performance.

FLEXPLATE/TORQUE CONVERTER VIBRATION TEST PROCEDURE

- Start engine.
- With engine at idle speed and transmission in "Park" (P) or "Neutral" (N), observe vibration.
- Key off.

**Remove or Disconnect**

1. Flexplate shield attaching bolts.
2. Flexplate to torque converter attaching bolts.
3. Rotate torque converter 120 degrees (1/3 turn).

**Install or Connect**

1. Flexplate to torque converter attaching bolts.

**Tighten**

- Bolts to 62 N•m (46 lb. ft.)
2. Flexplate shield attaching bolts.
- Start engine and check for vibration. Repeat procedure until best possible balance is obtained.

TECH 1 PARAMETER	IN PARK AT IDLE
ENGINE SPEED	550-750 RPM
TRANS OUTPUT SPD	0 RPM (1)
ENG COOL TEMP	85°C - 105°C (5)
TRANS FLUID TEMP	30°C - 130°C (5)
THROT POSITION	.4 - .6 V
THROTTLE ANGLE	0%
A/B/C RNG	OFF ON OFF
TRANS RANGE SW.	Park/Neutral
COMMANDED GEAR	1
ADAPTABLE SHIFT	NO (3)
1-2 SOL / 2-3 SOL	ON ON
CTR FDBK 1/2 2/3	ON ON (4)
3-2 CONTROL SOL	0%
3-2 CONTROL FDBK	OFF
HOT MODE	NO
TCC SLIP RPM	600-750
TCC SOLENOID	OFF
CTR FDBK TCC	OFF (4)
DESIRED PCS	1.01
ACTUAL PCS	1.01
PCS DUTY CYCLE	40 - 60%
VEHICLE SPEED	0
4WD LOW SWITCH	OFF
CRUISE ENGAGED	OFF
TCC BRAKE SWITCH	Released
KICKDOWN ENABLED	NO
1-2 SHIFT TIME	.3 - 1.35 Sec. (2)(3)
1-2 SHIFT ERROR	0 - 6.25 Sec. (2)(3)
2-3 SHIFT TIME	.3 - 1.35 Sec. (2)(3)
CURR. ADAPT CELL	N/A < 25% TP
TRANS CALIB ID	Internal ID Only
SYSTEM VOLTS	13.6
PRESS ADAPT 25% TP	-5 - 10
PRESS ADPT 40% TP	-5 - 10
PRESS ADPT 70% TP	-5 - 10
CURR. ADAPT PSI	-5 - 10

1. There may be a small speed reading due to vehicle vibration.
2. Zero until a shift occurs.
3. 'Yes' means the shift time is an accurate and valid number. (If shift was adaptable.)
If shift was adaptable, 'No' indicates the shift time is not accurate for one or more of the following reasons:
 - Transmission is in D2 or D1
 - There is a long shift delay
 - There is a long shift time
 - There has been a significant throttle angle change
 - Transmission is in hot mode
 - A shift starts too soon after the solenoids change states
 - Diagnostic codes are set (21, 22, 24, 28, 53, 58, 59, 72, 73, 75, 79, 81 or 82)
 - There has been a significant vehicle speed change
 - 4WD lo switch is on
4. Should match commanded solenoid state.
5. Normal operating temperature.

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Figure 14 Typical TECH 1 Data Values

**GARAGE SHIFTS
EXAMPLE ONLY
TECH 1 INFORMATION**

	PARK	DRIVE 4	REVERSE
ENGINE SPEED	639 RPM	538 RPM	524 RPM
TRANS FLUID TEMP	81°C	81°C	81°C
A / B / C RNG	OFF ON OFF	OFF ON ON	ON ON OFF
TRANS RANGE SW	P-N—	DRIVE 4	REV
DESIRED PCS	1.07 AMPS	1.07 AMPS	.96 AMPS
ACTUAL PCS	1.11 AMPS	1.07 AMPS	.98 AMPS

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

- ENGINE SPEED should drop approximately 50 RPM.
 - This verifies that the transmission has engaged.
- When DESIRED PCS = 1.07 AMPS, the transmission is commanded to minimum line pressure.
- ACTUAL PCS AMPS should always be within .16 AMPS of DESIRED PCS.
- TRANS RANGE SW should match the selected gear range.
 - IF not, the Transmission Pressure Switch Assembly should be checked.
 - A / B / C RNG should be used to identify the failed circuit.

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Figure 15 Example of TECH 1 Information (Garage Shifts)

1-2 UPSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application)**TECH 1 INFORMATION**

	1ST GEAR	2ND GEAR
ENGINE SPEED	2476 RPM	2146 RPM
TRANS OUTPUT SPD	767 RPM	1086 RPM
TRANS FLUID TEMP	83°C	83°C
THROT POSITION	2.16 VOLTS	2.12 VOLTS
THROTTLE ANGLE	41 %	38 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	1	2
ADAPTABLE SHIFT	NO	YES
1-2 SOL 2-3 SOL	ON ON	OFF ON
CTR FDBK 1/2 2/3	ON ON	OFF ON
TCC SLIP SPD	+257	+408
4WD LOW SWITCH	NO	NO
KICKDOWN ENABLED	NO	NO
1-2 SHIFT TIME	1.30 SEC	0.83 SEC
1-2 SHIFT ERROR	5.95 SEC	0.03 SEC
CURR ADAPT CELL		
PRESS ADPT 25%TP	-1	-1
PRESS ADPT 40%TP	-5	-5
PRESS ADPT 70%TP	-3	-3

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 1-2 UPSHIFT

- TRANS OUTPUT SPD must be greater than 300 RPM to upshift.
 - Refer to 1994 HYDRA-MATIC 4L60-E SHIFT SPEED CHART.
- ENGINE SPEED will drop approximately 250 RPM during a shift.
- TRANS RANGE SW should match the selected gear range.
 - In LOW the transmission will upshift to 2nd gear at high ENGINE SPEED and THROTTLE ANGLE.
 - In DRIVE 2 the transmission starts in 2nd gear.
- THROTTLE ANGLE should equal 0% at idle and increase as the accelerator is depressed until it equals 100% at wide open throttle.
 - If it decreases, check the throttle position sensor.
- If COMMANDED GEAR changes from 1 to 2 and the vehicle does not shift (ENGINE SPEED should drop approximately 250 RPM).
 - CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-14A).

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Figure 16 Example of TECH 1 Information (1-2 Upshifts)

1-2 UPSHIFTS (Cont.)**EXAMPLE ONLY (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application)****TECH 1 INFORMATION****HARSH 1-2 UPSHIFT**

- 1-2 SHIFT TIME and 1-2 SHIFT ERROR are not accurate unless ADAPTABLE SHIFT is YES.
- CURR ADAPT CELL indicates which PRESS ADPT XX%TP cell is being used to calculate the 1-2 shift pressure. This parameter is not accurate unless ADAPTABLE SHIFT is YES.
- CURR ADAPT PSI indicates the current adapt pressure used to calculate the 1-2 shift pressure. This parameter is not accurate unless ADAPTABLE SHIFT is YES.
- 1-2 SHIFT TIME is normally between 0.3 SEC and 1.35 SEC. However the TECH 1 will display the last shift time. (This value is not accurate unless ADAPTABLE SHIFT is YES).
 - If not, refer to Diagnosis Charts (7A-14A).
- 1-2 SHIFT ERROR should be below 1.0 SEC (This value is not accurate unless ADAPTABLE SHIFT is YES).
- PRESS ADPT 25%TP (25% - 40% TPS) is - 5 (lowering line pressure to adapt for harsh shifts) and 1-2 SHIFT TIME is below 0.3 SEC indicate an internal transmission problem. Refer to Diagnosis Charts (7A-14A).
- PRESS ADPT 40%TP (40% - 70% TPS) is - 5 (lowering line pressure to adapt for harsh shifts) and 1-2 SHIFT TIME is below 0.3 SEC indicate an internal transmission problem. Refer to Diagnosis Charts (7A-14A).
- PRESS ADPT 70%TP (70% - 100% TPS) is - 5 (lowering line pressure to adapt for harsh shifts) and 1-2 SHIFT TIME below 0.3 SEC indicate an internal transmission problem. Refer to Diagnosis Charts (7A-14A).

SOFT 1-2 UPSHIFT

- 1-2 SHIFT TIME and 1-2 SHIFT ERROR are not accurate unless ADAPTABLE SHIFT is YES.
- CURR ADAPT CELL indicates which PRESS ADPT XX%TP cell is being used to calculate the 1-2 shift pressure. This parameter is not accurate unless ADAPTABLE SHIFT is YES.
- CURR ADAPT PSI indicates the current adapt pressure used to calculate the 1-2 shift pressure. This parameter is not accurate unless ADAPTABLE SHIFT is YES.
- 1-2 SHIFT TIME is normally between 0.3 SEC and 1.35 SEC. However the TECH 1 will display the last shift time. (This value is not accurate unless ADAPTABLE SHIFT is YES).
 - If not, refer to Diagnosis Charts (7A-14A).
- 1-2 SHIFT ERROR should be below 1.0 SEC (This value is not accurate unless ADAPTABLE SHIFT is YES).
- PRESS ADPT 25%TP (25% - 40% TPS) is + 10 (increasing line pressure to adapt for soft shifts) and 1-2 SHIFT TIME is above 1.35 SEC indicate an internal transmission problem. Refer to Diagnosis Charts (7A-14A).
- PRESS ADPT 40%TP (40% - 70% TPS) is + 10 (increasing line pressure to adapt for soft shifts) and 1-2 SHIFT TIME is above 1.35 SEC indicate an internal transmission problem. Refer to Diagnosis Charts (7A-14A).
- PRESS ADPT 70%TP (70% - 100% TPS) is + 10 (increasing line pressure to adapt for soft shifts) and 1-2 SHIFT TIME is above 1.35 SEC indicates an internal transmission problem. Refer to Diagnosis Charts (7A-14A).

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Figure 17 Example of TECH 1 Information (1-2 Upshifts Continued)

2-3 UPSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application)**TECH 1 INFORMATION**

	2ND GEAR	3RD GEAR
ENGINE SPEED	3039 RPM	2770 RPM
TRANS OUTPUT SPEED	1760 RPM	1970 RPM
TRANS FLUID TEMP	86°C	86°C
THROT POSITION	2.82 VOLTS	2.84 VOLTS
THROTTLE ANGLE	61 %	61 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	2	3
1-2 SOL 2-3 SOL	OFF ON	OFF OFF
CTR FDBK 1/2 2/3	OFF ON	OFF OFF
4WD LOW SWITCH	NO	NO
2-3 SHIFT TIME	1.60 SEC	0.85 SEC

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 2-3 UPSHIFT

- TRANS OUTPUT SPD must be greater than 750 RPM to upshift.
 - Refer to 1994 HYDRA-MATIC 4L60-E SHIFT SPEED CHART.
- ENGINE SPEED will drop approximately 250 RPM during a shift.
- TRANS RANGE SW should match the selected gear range.
 - In LOW the transmission will upshift to 2nd gear at high ENGINE SPEED and THROTTLE ANGLE.
 - In DRIVE 2 the transmission starts in 2nd gear.
- THROTTLE ANGLE should equal 0% at idle and increase as the accelerator is depressed until it equals 100% at wide open throttle.
 - If it decreases, check the throttle position sensor.
- If COMMANDED GEAR changes from 2 to 3 and the vehicle does not shift (ENGINE SPEED should drop approximately 250 RPM).
 - CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-14A).

HARSH OR SOFT 2-3 UPSHIFT

- 2-3 SHIFT TIME is normally between 0.3 SEC and 1.35 SEC however the Tech 1 will display the last shift time. If the conditions of the last shift are unknown (lift foot upshift, manual upshift), it is recommended to repeat the upshift in the following manner.
 - To achieve an accurate shift time.
 - Accelerate the vehicle from rest holding the throttle steady.

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Figure 18 Example of TECH 1 Information (2-3 Upshifts)

3-4 UPSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application)**TECH 1 INFORMATION**

	3RD GEAR	4TH GEAR
ENGINE SPEED	1757 RPM	1617 RPM
TRANS OUTPUT SPD	1456 RPM	1534 RPM
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	3	4
1-2 SOL 2-3 SOL	OFF OFF	ON OFF
4WD LOW SWITCH	NO	NO
TRANS FLUID TEMP	42°C	42°C
THROTTLE ANGLE	20 %	21 %
CTR FDBK 1/2 2/3	OFF OFF	ON OFF
CRUISE ENGAGED	NO	NO

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 3-4 UPSHIFT

- TRANS OUTPUT SPD must be greater than 1250 RPM to upshift.
 - Refer to 1994 HYDRA-MATIC 4L60-E SHIFT SPEED CHART.
- ENGINE SPEED will drop approximately 100 RPM during a shift.
- TRANS RANGE SW should match the selected gear range.
 - In DRIVE 2 the transmission starts in 2nd gear.
 - In DRIVE 3 the transmission will not upshift to 4th gear but TCC will normally apply.
- THROTTLE ANGLE should equal 0% at idle and increase as the accelerator is depressed until it equals 100% at wide open throttle.
 - If it decreases, check the throttle position sensor.
- If COMMANDED GEAR changes from 3 to 4 and the vehicle does not shift (ENGINE SPEED should drop approximately 100 RPM).
 - CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-14A).
- If CRUISE ENGAGED displays YES, then the shift pattern requires a higher TRANS OUTPUT SPD.

Figure 19 Example of TECH 1 Information (3-4 Upshifts)

FOUR WHEEL DRIVE VEHICLES EXAMPLE ONLY

TECH 1 INFORMATION

	IN 4WD LOW	NOT IN 4WD LOW
ENGINE SPEED	1757 RPM	1617 RPM
TRANS OUTPUT SPD	1000 RPM	1000 RPM
COMMANDED GEAR	4	2
4WD LOW SWITCH	YES	NO

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

UPSHIFTING IN 4WD LOW (IN 4WD LOW, AND 4WD LOW SWITCH DISPLAYS YES)

- This is normal operation. The transmission upshifts are based on THROTTLE ANGLE and TRANS OUTPUT SPD. In 4WD LOW the transfer case changes the gear ratio between the transmission output shaft and the drive axles. The transmission output shaft must now spin considerably faster to maintain the same vehicle speed. Therefore, in 4WD LOW the transmission upshifts at a lower vehicle speed.
- If 4WD LOW SWITCH displays YES and the vehicle is not in 4WD LOW, then TRANS OUTPUT SPD will be incorrect. The PCM assumes this value is larger causing the PCM to command upshifts earlier than normal.
- If 4WD LOW SWITCH displays NO and the vehicle is in 4WD LOW, then TRANS OUTPUT SPD will be incorrect. The PCM assumes this value is smaller causing the PCM to command upshifts later than normal.

UPSHIFT TO 4TH GEAR AT A LOW VEHICLE SPEED (NOT IN 4WD LOW, HOWEVER 4WD LOW SWITCH DISPLAYS YES)

- If 4WD LOW SWITCH does not match the 4WD LOW indicator lites, check the 4WD LOW switch.
 - T-Trucks with electronic shift 4WD
 - The TCCM grounds a 12 V signal from the PCM.
 - T-Trucks with manual shift 4WD
 - The indicator lite circuit grounds a 12 V signal from the PCM.
 - K-Trucks with manual shift 4WD
 - The switch is located on the transfer case and it grounds a 12 V signal from the PCM.

LATE UPSHIFTS, NO UPSHIFTS OR UPSHIFTS AT HIGH ENGINE SPEED (IN 4WD LOW, HOWEVER 4WD LOW SWITCH DISPLAYS NO)

- If 4WD LOW SWITCH does not match the 4WD LOW indicator lites, check the 4WD LOW switch.
 - T-Trucks with electronic shift 4WD
 - The TCCM grounds a 12 V signal from the PCM.
 - T-Trucks with manual shift 4WD
 - The indicator lite circuit grounds a 12 V signal from the PCM.
 - K-Trucks with manual shift 4WD
 - The switch is located on the transfer case and it grounds a 12 V signal from the PCM.

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Figure 20 Example of TECH 1 Information (Four Wheel Drive Vehicles)

TCC SYSTEM EXAMPLE ONLY

TECH 1 INFORMATION

	RELEASED	APPLIED	RELEASED
ENGINE SPEED	1867 RPM	1353 RPM	1769
TRANS OUTPUT SPD	1909 RPM	1950 RPM	1883
TRANS FLUID TEMP	64°C	64°C	64°C
THROTTLE ANGLE	27 %	27 %	38 %
TRANS RANGE SW	DRIVE 4	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	4	4
1-2 SOL 2-3 SOL	ON OFF	ON OFF	ON OFF
HOT MODE	NO	NO	NO
TCC SLIP SPD	+531 RPM	-1 RPM	+447 RPM
COMMANDED TCC	OFF	ON	OFF
CTR. FDBK TCC	OFF	ON	OFF
4WD LOW SWITCH	NO	NO	NO
CRUISE ENGAGED	NO	NO	NO
TCC BRAKE SWITCH	CLOSED	CLOSED	CLOSED

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

TCC DOES NOT APPLY

- COMMANDED TCC will display ON only if
 - TRANS RANGE SW displays DRIVE 4 or DRIVE 3.
 - TRANS OUTPUT SPD must be greater than approximately 1800 RPM.
 - TCC BRAKE SWITCH displays APPLIED.
 - THROTTLE ANGLE must be at least approximately 2%.
 - THROTTLE ANGLE must remain steady.
 - TRANS FLUID TEMP must be above .
 - ENG COOL TEMP must be above .
 - TCC SLIP SPD is less than -60 RPM.
 - If CRUISE ENGAGED displays YES, then TCC uses a shift pattern that requires a higher TRANS OUTPUT SPD.
- CTR. FDBK TCC should always match COMMANDED TCC.
 - If they do not match, the TCC solenoid should be checked.
 - If they do match, refer to Driveability and Emissions Electrical Diagnosis Manual.
- TCC SLIP SPD should be +/-30 RPM if TCC is applied.

TCC DOES NOT RELEASE

- The Torque Converter Clutch is fed by 2nd gear fluid.
 - The earliest TCC can apply is 2nd gear.
- If HOT MODE displays YES, the TCC is engaged in 4th gear or Drive 3, 3rd gear, except for the following conditions:
 - TCC BRAKE SWITCH displays APPLIED.
 - THROTTLE ANGLE must be at least approximately 2%.
 - A DTC is current.
- CTR. FDBK TCC should always match COMMANDED TCC.
 - If they do not match, the TCC solenoid should be checked.
 - If they do match, refer to Driveability and Emissions Electrical Diagnosis Manual.

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Figure 21 Example of TECH 1 Information (TCC System)

3-2 DETENT DOWNSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application)**TECH 1 INFORMATION**

	3RD GEAR	2ND GEAR
ENGINE SPEED	1414 RPM	2430 RPM
TRANS OUTPUT SPD	1059 RPM	1315 RPM
TRANS FLUID TEMP	75°C	75°C
THROTTLE ANGLE	10 %	100 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	3	2
1-2 SOL 2-3 SOL	OFF OFF	OFF ON
CTR FDBK 1/2 2/3	OFF OFF	OFF ON
3-2 CONTROL SOL	90 %	47 %
3-2 CONTROL FDBK	ON (TOGGLES ON/OFF)	OFF (TOGGLES ON/OFF)
KICKDOWN ENABLED	NO	YES

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 3-2 DOWNSHIFT

- KICKDOWN ENABLED displays YES when THROTTLE ANGLE is greater than 70%.
- If COMMANDED GEAR changes from 3 to 2 and the vehicle does not shift (ENGINE SPEED should dramatically increase).
 - CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - If one does match, refer to Driveability and Emissions Electrical Diagnosis Manual.

HARSH OR SOFT 3-2 DOWNSHIFTS

- If 3-2 CONTROL SOL drops from 90% to a lower value during the shift, and the shift is harsh or soft.
 - 3-2 CONTROL FDBK should toggle ON/OFF.
 - If it does not, the 3-2 CONTROL SOL should be checked.
 - If 3-2 CONTROL SOL does toggle, refer to Driveability and Emissions Electrical Diagnosis Manual.

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Figure 22 Example of TECH 1 Information (3-2 Detent Downshifts)

4-2 DETENT DOWNSHIFTS**EXAMPLE ONLY****TECH 1 INFORMATION**

	4TH GEAR	2ND GEAR
ENGINE SPEED	919 RPM	2788 RPM
TRANS OUTPUT SPD	1390 RPM	1555 RPM
TRANS FLUID TEMP	79°C	79°C
THROTTLE ANGLE	0 %	100 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	2
1-2 SOL 2-3 SOL	ON OFF	OFF ON
CTR FDBK 1/2 2/3	ON OFF	OFF ON
3-2 CONTROL SOL	90 %	59 %
3-2 CONTROL FDBK	ON (TOGGLES ON/OFF)	ON (TOGGLES ON/OFF)
KICKDOWN ENABLED	NO	YES

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 4-2 DOWNSHIFT

- KICKDOWN ENABLED displays YES when THROTTLE ANGLE is greater than 70%.
- If COMMANDED GEAR changes from 3 to 2 and the vehicle does not shift (ENGINE SPEED should dramatically increase).
 - CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - If one does match, refer to Driveability and Emissions Electrical Diagnosis Manual.

HARSH OR SOFT 4-2 DOWNSHIFTS

- If 3-2 CONTROL SOL drops from 90% to a lower value during the shift, and the shift is harsh or soft.
 - 3-2 CONTROL FDBK should toggle ON/OFF.
 - If it does not, the 3-2 CONTROL SOL should be checked.
 - If 3-2 CONTROL SOL does toggle, refer to Driveability and Emissions Electrical Diagnosis Manual.

Figure 23 Example of TECH 1 Information (4-2 Detent Downshifts)

4-3 DETENT DOWNSHIFTS**EXAMPLE ONLY****TECH 1 INFORMATION**

	4TH GEAR	3RD GEAR
ENGINE SPEED	1434 RPM	2240 RPM
TRANS OUTPUT SPD	1434 RPM	1688 RPM
TRANS FLUID TEMP	80°C	80°C
THROTTLE ANGLE	19 %	54 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	3
1-2 SOL 2-3 SOL	ON OFF	OFF OFF
CTR FDBK 1/2 2/3	ON OFF	OFF OFF
3-2 CONTROL SOL	90 %	90 %
3-2 CONTROL FDBK	ON (TOGGLES ON/OFF)	ON (TOGGLES ON/OFF)
KICKDOWN ENABLED	NO	NO

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 4-3 DOWNSHIFT

- KICKDOWN ENABLED displays YES when THROTTLE ANGLE is greater than 70%.
- If COMMANDED GEAR changes from 3 to 2 and the vehicle does not shift (ENGINE SPEED should dramatically increase).
 - CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - If one does match, refer to Driveability and Emissions Electrical Diagnosis Manual.

Figure 24 Example of TECH 1 Information (4-3 Downshifts)

MANUAL DOWNSHIFTS**EXAMPLE ONLY****TECH 1 INFORMATION**

	DRIVE 4	DRIVE 3	DRIVE 2	LOW
ENGINE SPEED	1205 RPM	1543 RPM	2172 RPM	2087 RPM
TRANS OUTPUT SPD	1714 RPM	1638 RPM	1412 RPM	899 RPM
TRANS RANGE SW	DRIVE 4	DRIVE 3	DRIVE 2	LOW
COMMANDED GEAR	4	3	2	1
THROTTLE ANGLE	0 %	0 %	0 %	0 %

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

- ENGINE SPEED should increase as lower gears are selected.
- TRANS RANGE SW should match the selected gear range.
 - In LOW the transmission will upshift to 2nd gear at high ENGINE SPEED and THROTTLE ANGLE.
 - In DRIVE 2 the transmission starts in 2nd gear.
 - In DRIVE 3 the transmission will not upshift to 4th gear but TCC will normally apply.

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Figure 25 Example of TECH 1 Information (Manual Downshifts)

1994 HYDRA-MATIC 4L60-E SHIFT SPEED CHART

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS						
2.2L			10	25	50	10	25	50	10	25	50				
(LM2)	S	4.10	596	795	1143	1043	1441	2137	1491	1988	3280	3081	1491	1689	3230

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS						
			10	25	50	10	25	50	10	25	50				
4.3L (L35)	S/T	3.08/3.42	566	828	915	1090	1526	1787	1438	1918	2659	2441	1220	1526	2921
	M/L	3.42/3.73	566	828	915	1090	1526	1787	1438	1918	2659	2441	1220	1526	2921
4.3L (LB4)	G	3.42/3.73	479	654	959	872	1264	1918	1395	1831	2572	2267	1220	1351	2528
	C/K	3.08/3.42	479	654	959	959	1264	1918	1395	1831	2572	2267	1220	1351	2528
	C/K	3.73/4.10	523	697	784	1002	1351	1613	1395	1831	2572	2049	1220	1351	2528
	M	3.23	479	654	959	959	1526	1918	1395	1831	2572	2267	1220	1351	2528
	M	3.42	523	784	1046	915	1438	1962	1395	1918	2659	2049	1220	1351	2528
	S/T	3.08/3.42	479	654	959	915	1526	1918	1395	1831	2572	2267	1220	1351	2528

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS						
			10	25	50	10	25	50	10	25	50				
5.0L (L03)	C10/G10/G20	3.08	481	666	851	777	1184	1591	1184	1665	2479	2035	962	1258	2368
	C20/K10/K20	3.42													
	C10/G10/G20	3.42	529	773	936	814	1302	1750	1221	1668	2482	2035	976	1261	2360
	C20/K10/K20	3.73													
	G20	3.73	536	849	938	894	1385	1788	1251	1698	2503	2011	983	1251	2369
	C20/K10/K20	4.10													

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS						
			10	25	50	10	25	50	10	25	50				
5.7L (L05)	C10/G10/G20	3.08	444	629	851	777	1184	1591	1184	1628	2479	2035	962	1295	2368
	C20/K10/K20	3.42													
	C10/G10/G20	3.42	447	691	936	814	1302	1709	1221	1668	2482	2035	976	1261	2360
	C20/K10/K20	3.73													
	C10/G20	3.73	491	759	938	894	1385	1788	1251	1698	2503	2011	983	1251	2369
	C20/K20	4.10													

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS						
		TPS	10	25	50	10	25	50	10	25	50				
6.5L (DIESEL)	G	3.42	370	534	822	698	1068	1644	1315	1561	2096	1767	945	1191	1931
	G	3.08	370	518	814	703	1073	1665	1295	1554	2109	1776	962	1147	1924
	C10	3.42	370	534	822	698	1068	1644	1315	1561	2096	2013	945	1191	2260
	C20/K	3.73													
	C10	3.08	370	518	814	703	1036	1665	1295	1517	2109	2035	962	1147	2257
	C20/K	3.42													
G	3.73	358	537	806	716	1075	1657	1299	1568	2105	1792	940	1164	1926	

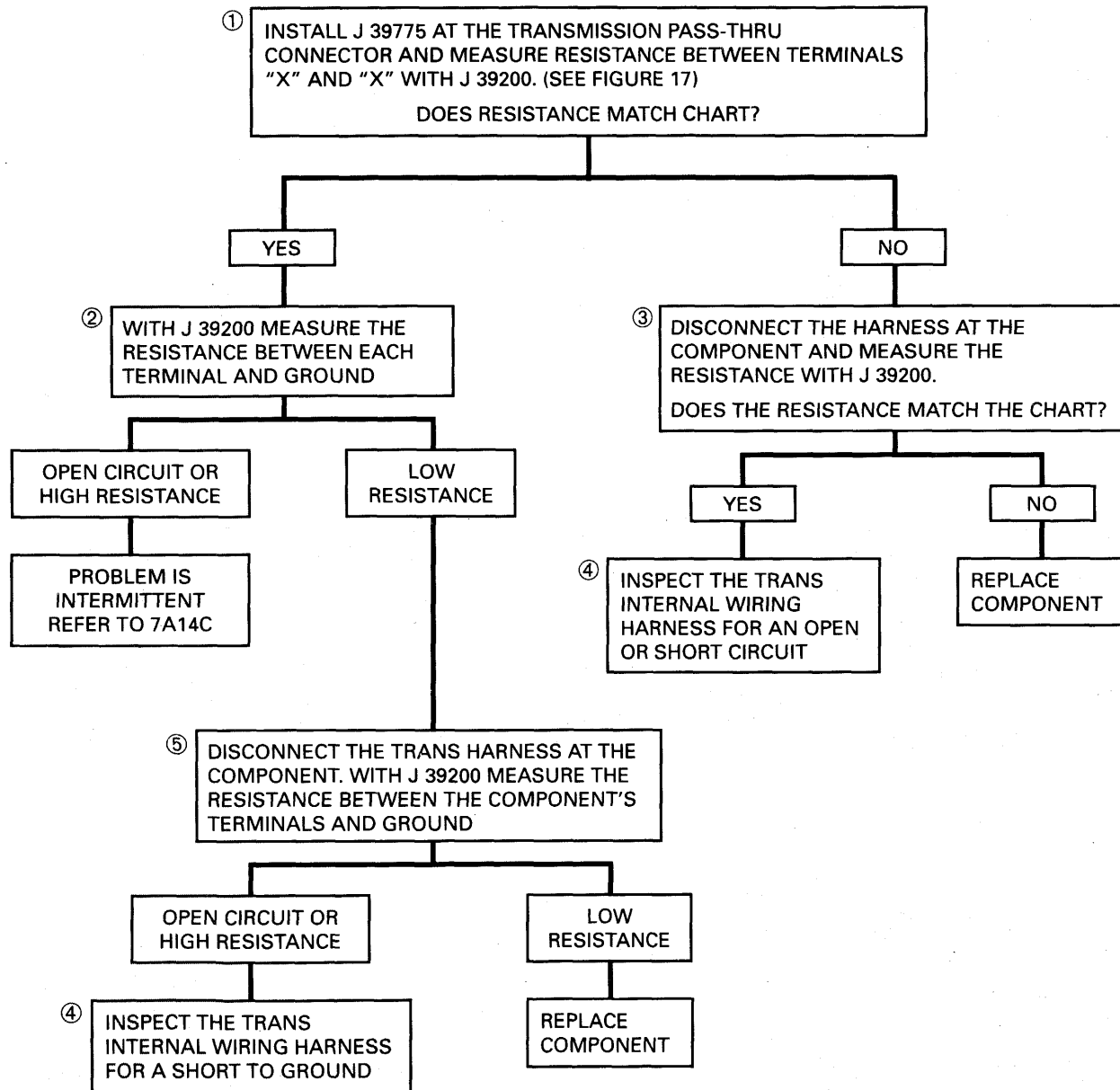
1. ALL SPEEDS ARE GIVEN IN TRANSMISSION OUTPUT SHAFT RPM
2. SPEEDS ARE BASED ON PERCENT THROTTLE POSITION SENSOR (TPS) DATA
3. USE A TECH 1 OR OTHER SCAN TOOL TO MONITOR THIS DATA
4. ALL SHIFT SPEEDS ARE APPROXIMATE

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Figure 26 4L60-E Shift Speed Chart

NOTE: This procedure cannot be used on the pressure switch assembly. See figure 18.

4L60-E TRANSMISSION INTERNAL WIRING HARNESS CHECK



① This test measures the resistance of the component at the transmission pass-thru connector.

② This test checks for a short to ground in the internal wiring harness or component.

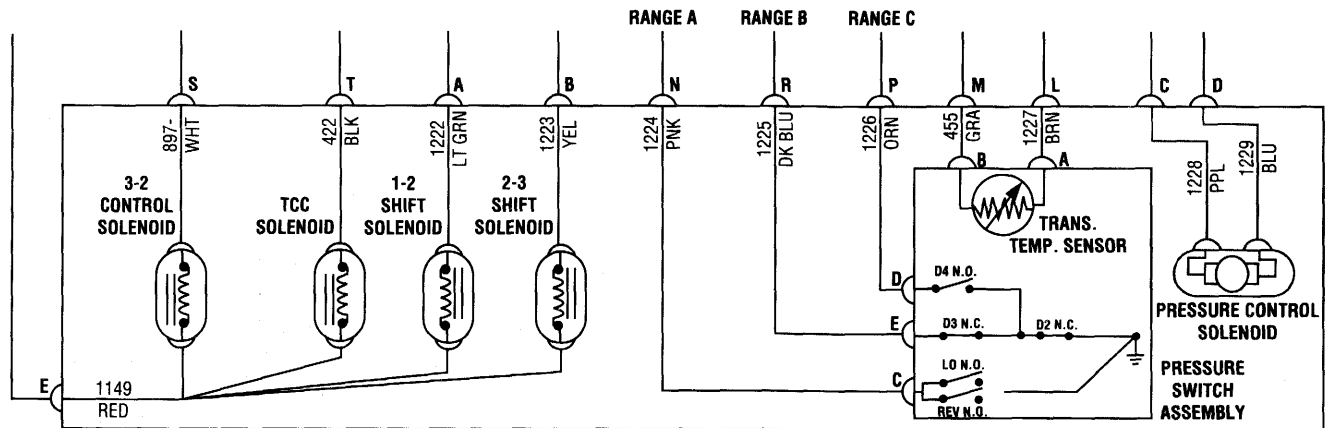
③ This test measures the resistance of the component.

④ Check the internal wiring harness for continuity, pinched wires and corrosion.

⑤ This test checks for a short to ground in the component (cannot be used on TCC solenoid).

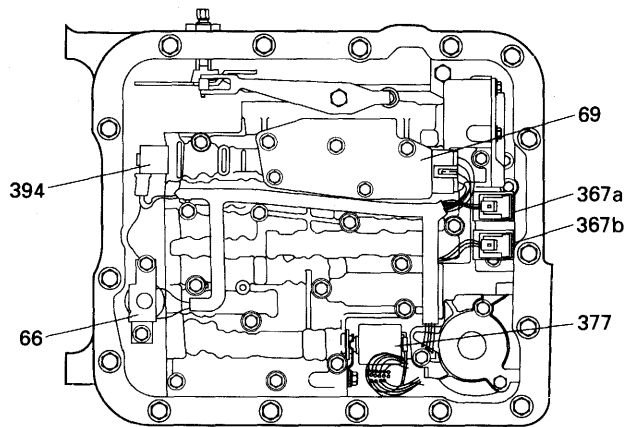
PH0217-4L60-E

Figure 27 Internal Wiring Harness Check

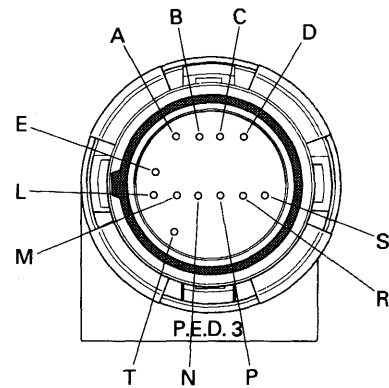


INTERNAL TRANSMISSION WIRING HARNESS

N.C. = NORMALLY CLOSED SWITCH
 N.O. = NORMALLY OPEN SWITCH



- 66 SOLENOID ASSEMBLY, WIRING HARNESS AND
 69 SWITCH ASSEMBLY, TRANSMISSION PRESSURE
 367a 1-2 SHIFT SOLENOID
 367b 2-3 SHIFT SOLENOID
 377 PRESSURE CONTROL SOLENOID
 394 3-2 CONTROL SOLENOID



CAVITY	FUNCTION
A	1-2 SHIFT SOLENOID (LOW)
B	2-3 SHIFT SOLENOID (LOW)
C	PRESSURE CONTROL SOLENOID (HIGH)
D	PRESSURE CONTROL SOLENOID (LOW)
E	BOTH SHIFT SOLENOIDS, TCC SOLENOID, AND 3-2 CONTROL SOLENOID (HIGH)
L	TRANSMISSION FLUID TEMPERATURE (HIGH)
M	TRANSMISSION FLUID TEMPERATURE (LOW)
N	RANGE SIGNAL "A"
P	RANGE SIGNAL "C"
R	RANGE SIGNAL "B"
S	3-2 CONTROL SOLENOID (LOW)
T	TCC SOLENOID (LOW)

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Figure 28 Wiring Diagram

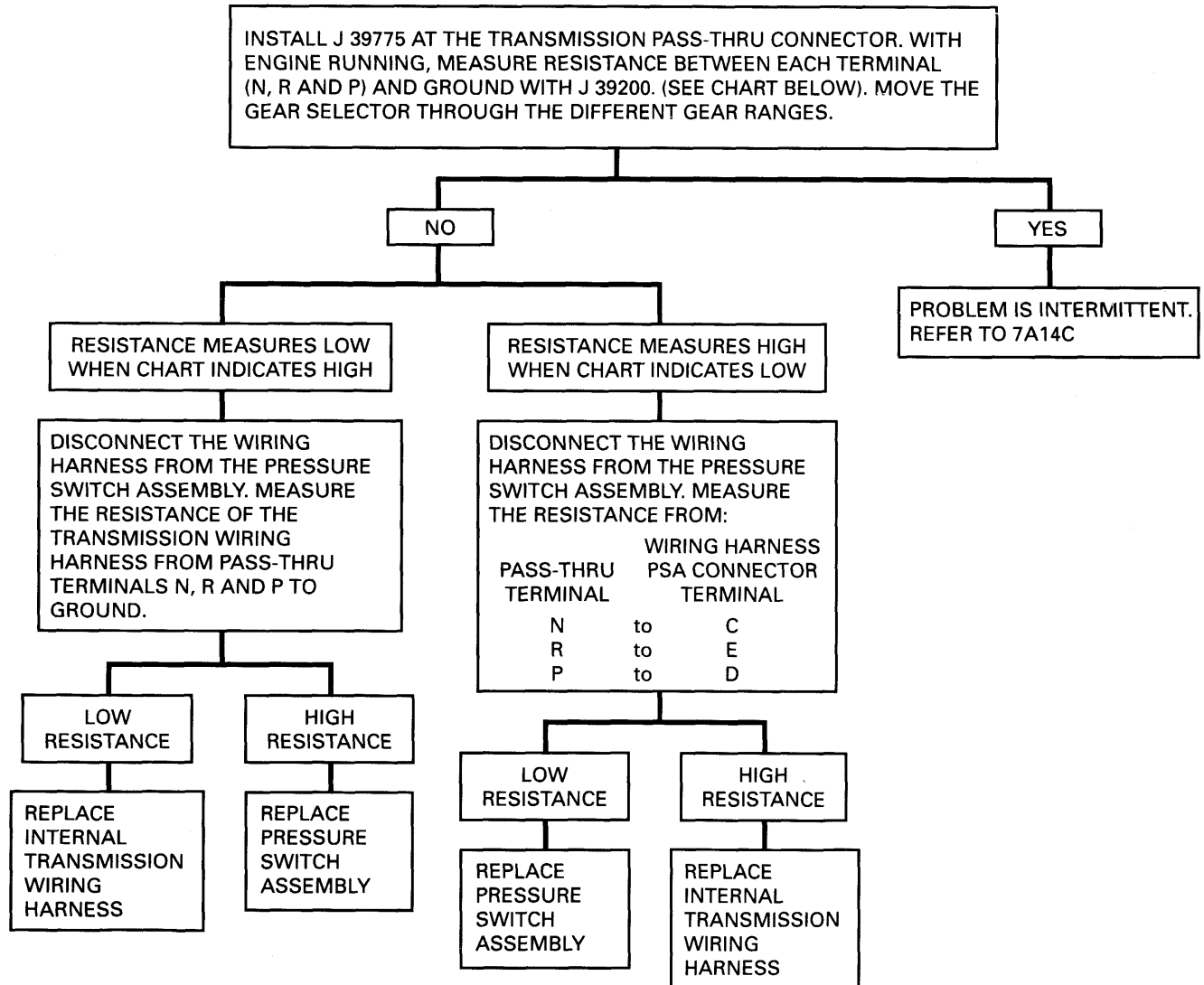
4L60-E COMPONENT RESISTANCE CHART

COMPONENT	WIRE COLOR	PASS-THRU PIN	RESISTANCE @ 20°C	CKT #
1-2 SHIFT SOLENOID	RED	E *	20 - 40 Ohms	1149B
	GRN LT	A		1222
2-3 SHIFT SOLENOID	RED	E *	20 - 40 Ohms	1149A
	YEL	B		1223
3-2 CONTROL SOLENOID	RED	E *	9 - 14 Ohms	1149C
	WHT	S		897
PRESSURE CONTROL SOLENOID	PPL	C	3.5 - 8 Ohms	1228
	BLU LT	D		1229
TCC SOLENOID	RED	E *	20 - 40 Ohms	1149E
	BLACK	T		422A

* Spliced internally to Pin E.

Figure 29 Component Resistance Chart

4L60-E TRANSMISSION PRESSURE SWITCH ASSEMBLY RESISTANCE CHECK



Pressure Switch Assembly (PSA) Resistance Chart

Gear Selector Position	Range		
	A	B	C
PARK	H	L	H
REVERSE	L	L	H
NEUTRAL	H	L	H
D4	H	L	L
D3	H	H	L
D2	H	H	H
D1	L	H	H

When range "X" is measured for resistance to ground,
 H = High resistance (over 100 Ohms) - open circuit
 L = Low resistance (under 200 Ohms) - grounded circuit

IMPORTANT:

Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple transmission Diagnostic Trouble Codes will set. Be sure to clear these codes when finished with this procedure.

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Figure 30 Pressure Switch Assembly Resistance Check

HYDRA-MATIC 4L60-E ELECTRONIC COMPONENT MALFUNCTIONS

This chart gives some general information about electronic component malfunctions. Use this information to become familiar with possible conditions caused by transmission/vehicle electrical components. Refer to the diagnosis charts for more specific information.

COMPONENT/SYSTEM	CAN EFFECT
Throttle Position Sensor	- Shift pattern (erratic). - Shift quality (firm or soft). - Engine (rough).
Output Speed Sensor	- Shift pattern (erratic). - TCC apply (at wrong time). - Shift quality (harsh or soft).
Pressure Switch Assembly	- TCC apply (no apply). - Shift pattern (no fourth gear in hot mode). - Shift quality (harsh). - Line pressure (high). - Manual downshift (erratic). - No 4th gear if in hot mode.
Transmission Fluid Temperature Sensor	- TCC control (on or off). - Shift quality (harsh or soft).
Engine Coolant Temperature Sensor	- TCC control (no apply). - Shift quality (harsh).
Shift Solenoids	- Gear application (wrong gear, only two gears, no shift).
Brake Switch	- TCC apply (no apply). - No 4th gear if in hot mode.
System Voltage	- Line pressure (high). - Gear application (third gear only). - TCC control (no apply). - No 4th gear if in hot mode.
3-2 Control Solenoid	- Gear application (third gear only). - 3-2 downshifts (flare or tie-up).
Pressure Control Solenoid	- Line pressure (high or low). - Shift quality (harsh or soft).
TCC Solenoid	- TCC apply (no apply). - No 4th gear if in hot mode.
4WD Low Switch	- Incorrect shift pattern.

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Figure 31 Component Malfunctions

CONDITION	INSPECT COMPONENT	FOR CAUSE
OIL PRESSURE HIGH OR LOW (Verify With Gage – Refer To Line Pressure Check Procedure)	- Oil Pump Assembly (4) - Oil Filter (72) - Valve Body (60) - Pressure Control Solenoid (377) - System Voltage - Pressure Switch Assembly (69) - Case (8) - Possible Codes: - 24 Vehicle Speed Sensor Signal Low - 52 Long System Voltage High - 53 System Voltage High - 72 Vehicle Speed Sensor Loss - 73 Pressure Control Solenoid Current - 75 System Voltage Low - 81 2-3 Shift Solenoid Circuit Fault - 82 1-2 Shift Solenoid Circuit Fault	- Pressure regulator valve (216) stuck. - Pressure regulator valve spring (217). - Rotor guide (211) omitted or misassembled. - Rotor (212) cracked or broken. - Reverse boost valve (219) or sleeve (220) stuck, damaged or incorrectly assembled. - Orifice hole in pressure regulator valve (217) plugged. - Sticking slide (203) or excessive rotor clearance. - Pressure relief ball (228) not seated or damaged. - Porosity in pump cover or body. - Wrong pump cover. - Pump faces not flat. - Excessive rotor clearance. - Intake pipe restricted by casting flash. - Cracks in filter body or intake pipe. - O-ring seal (71) missing, cut or damaged. - Wrong grease used on rebuild. - Manual valve (340) scored or damaged. - Spacer plate (48) or gaskets (47 and 52) incorrect, misassembled or damaged. - Face not flat. 2-3 Shift valve (369) stuck. - Checkballs omitted or misassembled. - Damage to pins or seal. - Contamination. - Damaged seals. - Case to valve body face not flat.
HARSH SHIFTS	- Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low) - 28 Fluid Pressure Switch Assembly Fault - 73 Pressure Control Solenoid Current	
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION		

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Figure 33 Diagnosis Chart A

CONDITION	INSPECT COMPONENT	FOR CAUSE
HARSH SHIFTS (Continued)	• Throttle Position Sensor • Vehicle Speed Sensor (36) • Pressure Switch Assembly (69) • Trans Fluid Temperature Sensor (69) • Engine Coolant Temperature Sensor • Pressure Control Solenoid (377)	- Open or shorted circuit. - Open or shorted circuit. - Contamination. - Damaged seals. - Open or shorted circuit. - Open or shorted circuit. - Damage to pins or seal. - Contamination.
INACCURATE SHIFT POINTS	• Oil Pump Assembly (4) • Valve Body Assembly (60) • Case (8) • Throttle Position Sensor • Vehicle Speed Sensor (36) • 4WD Low Switch	- Stuck pressure regulator valve (216). - Sticking pump slide (203). - Spacer plate (48) or gaskets (47 and 52) misassembled, damaged or incorrect. - Porous or damaged valve body pad. - 2-4 Servo Assembly (12-29) a. 2-4 accumulator porosity. b. Damaged servo piston seals. c. Apply pin damaged or improper length. - 2-4 Band Assembly (602). a. Burned. b. Anchor pin not engaged. - Disconnected. - Damage. - Disconnected. - Damaged. - Bolt not tightened. - Disconnected. - Damaged.
EARLY SHIFTS	• Possible Codes: - 69 TCC Stuck "ON"	
FIXED SHIFT POINTS	• Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low)	
1ST GEAR RANGE ONLY - NO UPSHIFT	• Valve Body (60) • Case (8) • Shift Solenoids (379) • 2-4 Servo Assembly (12-29)	- 1-2 Shift valve (366) sticking. - Spacer plate (48) or gaskets (47 and 52) mispositioned or damaged. - Case to valve body face not flat or damaged. - Stuck or damaged. - Electrical connection. - Restricted or blocked apply passages case. - Nicks or burrs on servo pin (13) or pin bore in case - 4th Servo piston (25) in backwards.
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION		

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Figure 34 Diagnosis Chart B

CONDITION	INSPECT COMPONENT	FOR CAUSE
1ST GEAR RANGE ONLY – NO UPSHIFTS (Continued)	• 2-4 Band Assembly (602)	– 2-4 Band (602) worn or damaged. – Band anchor pin not engaged.
SLIPS IN 1ST GEAR	• Forward Clutch Assembly • Forward Clutch Accumulator • Input Housing and Shaft Assembly (621) • Valve Body (60) • Low Roller Clutch (678) • Torque Converter (1) • 1-2 Accumulator Assembly (54-59) • Line Pressure • 2-4 Servo Assembly (12-29)	– Clutch plates (649) worn. – Porosity or damage in forward clutch piston (630). – Forward clutch piston inner and outer seals (629) missing, cut or damaged. – Input housing to forward clutch housing O-ring seal (622) missing, cut or damaged. – Damaged forward clutch housing (628). – Forward clutch housing retainer and ball assembly (627) not sealing or damaged. – Piston seal (353) missing, cut or damaged. – Piston (354) out of its bore. – Porosity in the piston or valve body (350). – Stuck abuse valve (357). – Turbine shaft seals (619) missing, cut or damaged. – 1-2 Accumulator valve (371) stuck. – Face not flat, damaged lands or interconnected passages. – Spacer plate (48) or gaskets (47 and 52) incorrect, mispositioned or damaged. – Damage to lugs or inner ramps. – Rollers not free moving. – Inadequate spring tension. – Damage to inner splines. – Lube passage plugged. – Stator roller clutch not holding. – Porosity in piston (56) or 1-2 Accumulator cover and pin assembly (57). – Damaged ring grooves on piston. – Piston seal (55) missing, cut or damaged. – Valve body to spacer plate gasket (52) at 1-2 Accumulator cover, missing or damaged. – Leak between piston and pin. – Broken 1-2 Accumulator spring (54). – (See Causes of High or Low Oil Pressure.) – 4th Servo piston (25) in backwards.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0015-4L60-E

Figure 35 Diagnosis Chart C

CONDITION	INSPECT COMPONENT	FOR CAUSE
SLIPPING OR ROUGH 1-2 SHIFT	• Valve Body Assembly (60) • 2-4 Servo Assembly (12-29) • 2nd Accumulator (54-59) • 2-4 Band (602) • Oil Pump Assembly (4) or Case (8)	- 1-2 Shift valve train (365-366) stuck. - Gaskets (47 and 52) or spacer plate (48) incorrect, mispositioned or damaged. - 1-2 Accumulator valve (371) stuck. - Face not flat. - Apply pin (13) too long or too short. - 2nd servo apply piston seal missing, cut or damaged. - Restricted or missing oil passages. - Servo bore in case damaged. - Porosity in 1-2 accumulator housing (57) or piston (56). - Piston seal or groove damaged. - Nicks or burrs in 1-2 accumulator housing. - Missing or restricted oil passage. - Worn or mispositioned. - Faces not flat.
NO 2-3 SHIFT OR 2-3 SHIFT SLIPPING, ROUGH OR HUNTING	• Converter (1) • Oil Pump (4) • Valve Body (60) • Input Housing Assembly (621) • Case (8) • 2-4 Servo Assembly (12-29) • Possible Codes: - 24 Vehicle Speed Sensor Signal Low - 72 Vehicle Speed Sensor Loss	- Internal damage. - Stator shaft (214) sleeve scored or off location. - 2-3 Valve train (268-269) stuck. - Accumulator valve (371) stuck. - Spacer plate (48) or gaskets (47 and 52) incorrect, mispositioned or damaged. - Clutch plates worn [3-4 (654) or forward (649)]. - Excessive clutch plate travel. - Cut or damaged piston seals [3-4 (624) or forward (629)]. - Porosity in input clutch housing (621) or piston (623). - 3-4 Piston checkball (620) stuck, damaged or not sealing. - Restricted apply passages. - Forward clutch piston retainer and ball assembly (627) not seating. - Sealing balls loose or missing. - 3rd Accumulator retainer and ball assembly not seating. - 2nd Apply piston seals (18 and 19) missing, cut or damaged.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0016-4L60-E

Figure 36 Diagnosis Chart D

CONDITION	INSPECT COMPONENT	FOR CAUSE
2ND AND 3RD GEARS ONLY OR 1ST AND 4TH GEARS ONLY	• Possible Codes: - 82 1-2 Shift Solenoid Circuit Fault • Shift Solenoids (379)	- Sediment. - Electrical Connection. - Damaged seal.
THIRD GEAR ONLY	• Possible Codes: - 52 Long System Voltage High - 53 System Voltage High - 66 3-2 Control Solenoid Circuit Fault - 75 System Voltage Low - 81 2-3 Shift Solenoid Circuit Fault • System Voltage • 3-2 Control Solenoid (394)	
3-2 FLARE OR TIE-UP	• 3-2 Control Solenoid (394)	- Shorted or damaged. - Contamination. - Damaged seal.
NO 3-4 SHIFT/SLIPPING OR ROUGH 3-4 SHIFT	• Oil Pump Assembly (4) • Valve Body Assembly (60) • 2-4 Servo Assembly (12-29) • Case (8) • Input Housing Assembly (621) • 2-4 Band Assembly (602)	- Faces not flat. - Pump cover retainer and ball assembly omitted or damaged. - Valves stuck. • 2-3 Shift valve (368-369) train. • Accumulator valve (371). • 1-2 Shift valve train (365-366). • 3-2 Control valve (391). - Spacer plate (48) or gaskets (47 and 52) incorrect, mispositioned or damaged. - Incorrect band apply pin (13). - Missing or damaged servo seals (26 and 27). - Porosity in pistons, cover or case. - Damaged piston seal grooves. - Plugged or missing orifice cup plug (11). - 3rd Accumulator retainer and ball assembly leaking. - Porosity in 3-4 accumulator piston (44) or bore. - 3-4 Accumulator piston seal (45) or seal grooves damaged. - Plugged or missing orifice cup plug. - Restricted oil passage. - Refer to Slipping 2-3 Shift. - Worn or misassembled.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0017-4L60-E-R1

Figure 37 Diagnosis Chart E

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO 3-4 SHIFT/SLIPPING OR ROUGH 3-4 SHIFT (Continued)	• Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low) - 28 Fluid Pressure Switch Assembly Fault - 37 Brake Switch Stuck "ON" - 38 Brake Switch Stuck "OFF" - 67 TCC Solenoid Circuit Fault	
R NO REVERSE OR SLIPS IN REVERSE	• Input Housing Assembly (621) • Manual Valve Link (705) • Oil Pump Assembly (4) • Valve Body Assembly (60) • Reverse Input Clutch Assembly (605) • Lo And Reverse Clutch	- 3-4 Apply ring (625) stuck in applied position. - Forward clutch not releasing. - Turbine shaft seals (619) missing, cut or damaged. - Disconnected. - Retainer and ball assembly missing or damaged. - Stator shaft seal rings (230) or ring grooves damaged. - Stator shaft sleeve scored or damaged. - Reverse boost valve (219) stuck, damaged or misassembled. - Cup plug missing. - Restricted oil passage. - Faces not flat. - Converter clutch valve (224) stuck. - 2-3 Shift valve (369) stuck. - Manual linkage (705) not adjusted. - Spacer plate (48) and gaskets (47 and 52) incorrect, mispositioned or damaged. - Lo overrun valve (361) stuck. - Orificed cup plug restricted, missing or damaged. - Clutch plate (612) worn. - Reverse input housing and drum assembly (605) cracked at weld. - Clutch plate retaining ring out of groove. - Return spring assembly retaining ring (610) out of groove. - Seals (608) cut or damaged. - Restricted apply passage. - Porosity in piston (607). - Belleville plate (611) installed incorrectly. - Excessive clutch plate travel. - Oversized housing. - Clutch plates (682) worn. - Porosity in piston (695). - Seals (696) damaged. - Return spring assembly retaining ring (693) mispositioned. - Restricted apply passage.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0018-4L60-E

Figure 38 Diagnosis Chart F

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO PART THROTTLE OR DELAYED DOWNSHIFTS	• 2-4 Servo Assembly (12-29) • Valve Body Assembly (60)	- Servo cover retaining ring (29) omitted or misassembled. - 4th Apply piston (25) damaged or misassembled. - Servo inner housing (20) damaged or misassembled. - 3-2 Downshift valve (389) stuck. - 4-3 Sequence valve body channel blocked.
HARSH GARAGE SHIFT	• Valve Body Assembly (60)	- Orifice cup plug missing. - Checkball missing.
NO OVERRUN BRAKING - MANUAL 3-2-1	• External Linkage • Valve Body Assembly (60) • Input Clutch Assembly (621)	- Not adjusted properly. - 4-3 Sequence valve (382) stuck. - Checkball mispositioned. - Spacer plate (48) and gaskets (47 and 52) incorrect, damaged or mispositioned. - Turbine shaft oil passages plugged or not drilled. - Turbine shaft seal rings (619) damaged. - Turbine shaft sealing balls loose or missing. - Porosity in forward (630) or overrun clutch piston (632). - Overrun piston seals (631) cut or damaged. - Overrun piston checkball (633) not sealing.
NO TORQUE CONVERTER CLUTCH APPLY	• Electrical • TCC Solenoid • Engine Speed Sensor • Converter (1) • Engine Coolant Temperature Sensor • Oil Pump Assembly (4)	- 12 Volts not supplied to transmission. - Outside electrical connector damaged. - Inside electrical connector, wiring harness or solenoid damaged. - Electrical short (pinched solenoid wire). - Solenoid not grounded. - Internal damage. - Converter clutch valve (224) stuck or assembled backwards. - Converter clutch valve retaining ring (222) mispositioned. - Pump to case gasket (6) mispositioned. - Orifice cup plug restricted or damaged. - Solenoid O-ring seal (67) cut or damaged. - High or uneven bolt torque (pump body to cover).

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0019-4L60-E

Figure 39 Diagnosis Chart G

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO TORQUE CONVERTER CLUTCH APPLY (Continued)	• Trans Fluid Temperature Sensor (69) • Input Housing and Shaft (621) • Brake Switch • Pressure Switch Assembly (69) • Valve Body Assembly (60) • Solenoid Screen • Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low) - 28 Fluid Pressure Switch Assembly Fault - 37 Brake Switch Stuck "ON" - 38 Brake Switch Stuck "OFF" - 52 Long System Voltage High - 53 System Voltage High - 67 TCC Solenoid Circuit Fault - 75 System Voltage Low - 81 2-3 Shift Solenoid Circuit Fault	- Turbine shaft O-ring seal (618) cut or damaged. - Turbine shaft retainer and ball assembly (617) restricted or damaged. - Contamination. - Damaged seals. - TCC signal valve (380) stuck. - Solenoid O-ring leaking. - Blocked.
TORQUE CONVERTER CLUTCH SHUDDER	• Torque Converter Assembly (1) • Oil Pump Assembly (4) • Oil Filter (72) • Miscellaneous • Input Housing and Shaft Assembly (621)	- Internal damage. - Converter clutch valve (224) stuck. - Restricted oil passage. - Crack in filter body. - Flash restricting filter neck. - O-ring seal (71) cut or damaged. - Low oil pressure. - Engine not tuned properly. - Turbine shaft O-ring (618) cut or damaged. - Turbine shaft retainer and ball assembly (617) restricted or damaged.
TCC APPLY WITH A COLD ENGINE	• Possible Codes: - 14 Engine Coolant Temp Sensor Circuit (High) - 15 Engine Coolant Temp Sensor Circuit (Low)	
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION		

PH0020-4L60-E

Figure 40 Diagnosis Chart H

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO TORQUE CONVERTER CLUTCH RELEASE	• TCC Solenoid • Converter (1) • Valve Body Assembly (60) • Oil Pump Assembly (4) • PCM	- External ground. - Clogged exhaust orifice. - Internal damage. - Converter clutch apply valve stuck in apply position. - Converter clutch valve (224) stuck. - External ground.
TCC ON IN ALL GEARS	• Possible Codes: - 69 TCC Stuck "On"	
DRIVES IN NEUTRAL	• Forward Clutch • Manual Valve Link (705) • Case (8)	- Not releasing. - Disconnected. - Face not flat. - Internal leakage.
2ND GEAR START (DRIVE RANGE)	• Forward Clutch Sprag Assembly (642)	- Sprag assembly installed backwards.
NO PARK	• Parking Linkage (63, 79-90)	- Actuator rod assembly (85) bent or damaged. - Actuator rod spring binding or improperly crimped. - Actuator rod not attached to inside detent lever (788). - Parking lock bracket (86) damaged or not torqued properly. - Inside detent lever (88) not torqued properly. - Detent roller and spring assembly (63) mispositioned or not torqued properly. - Parking pawl (81) binding or damaged.
RATCHETING NOISE	• Parking Pawl (81)	- Parking pawl return spring (80) weak, damaged or misassembled.
OIL OUT THE VENT	• Oil Pump (4) • Miscellaneous	- Chamfer in pump body rotor pocket too large. - Fluid level - overfilled.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0021-4L60-E

Figure 41 Diagnosis Chart I

CONDITION	INSPECT COMPONENT	FOR CAUSE
VIBRATION IN REVERSE AND WHINING NOISE IN PARK	• Oil Pump (4)	– Broken vane rings (210).
NO DRIVE IN ALL RANGES	• Torque Converter (1)	– Converter to flex plate bolts missing.
NO DRIVE IN DRIVE RANGE	• Torque Converter (1)	– Stator roller clutch not holding. – Converter not bolted to flex plate.
FRONT OIL LEAK	• Torque Converter (1) • Torque Converter Seal (243)	– Welded seam leaking. – Damaged converter hub. – Damaged seal assembly. – Missing garter spring.
DELAY IN DRIVE AND REVERSE	• Torque Converter (1)	– Converter drainback.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0022-4L60-E

Figure 42 Diagnosis Chart J

FLUID LEAK DIAGNOSIS AND REPAIR

The cause of most external leaks can generally be located and repaired with the transmission in the vehicle.

METHODS FOR LOCATING LEAKS

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut the engine off and look for fluid spots on the paper.
6. Make necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder (foot powder) to the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Shut the engine off.
5. Inspect the suspected leak area and trace the leak path through the powder to find the source.
6. Make necessary repairs.

Dye and Black Light Method

1. Follow the manufacturer's recommendation for the amount of dye to be used.
2. Find the leak with a black light.
3. Make necessary repairs.

REPAIRING THE LEAK

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check to be sure that the following conditions are correct as they may cause a leak.

Gaskets

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Improperly torqued fasteners or dirty/damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs, or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant used (where applicable).
- Porosity.

Seals

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Damaged seal bore (scratched, burred or nicked).

- Damaged or worn seal.
- Improper installation.
- Cracks in component.
- Manual or output shaft surface scratched, nicked, or missing.
- Loose or worn bearing causing excess seal wear.

POSSIBLE POINTS OF OIL LEAKS

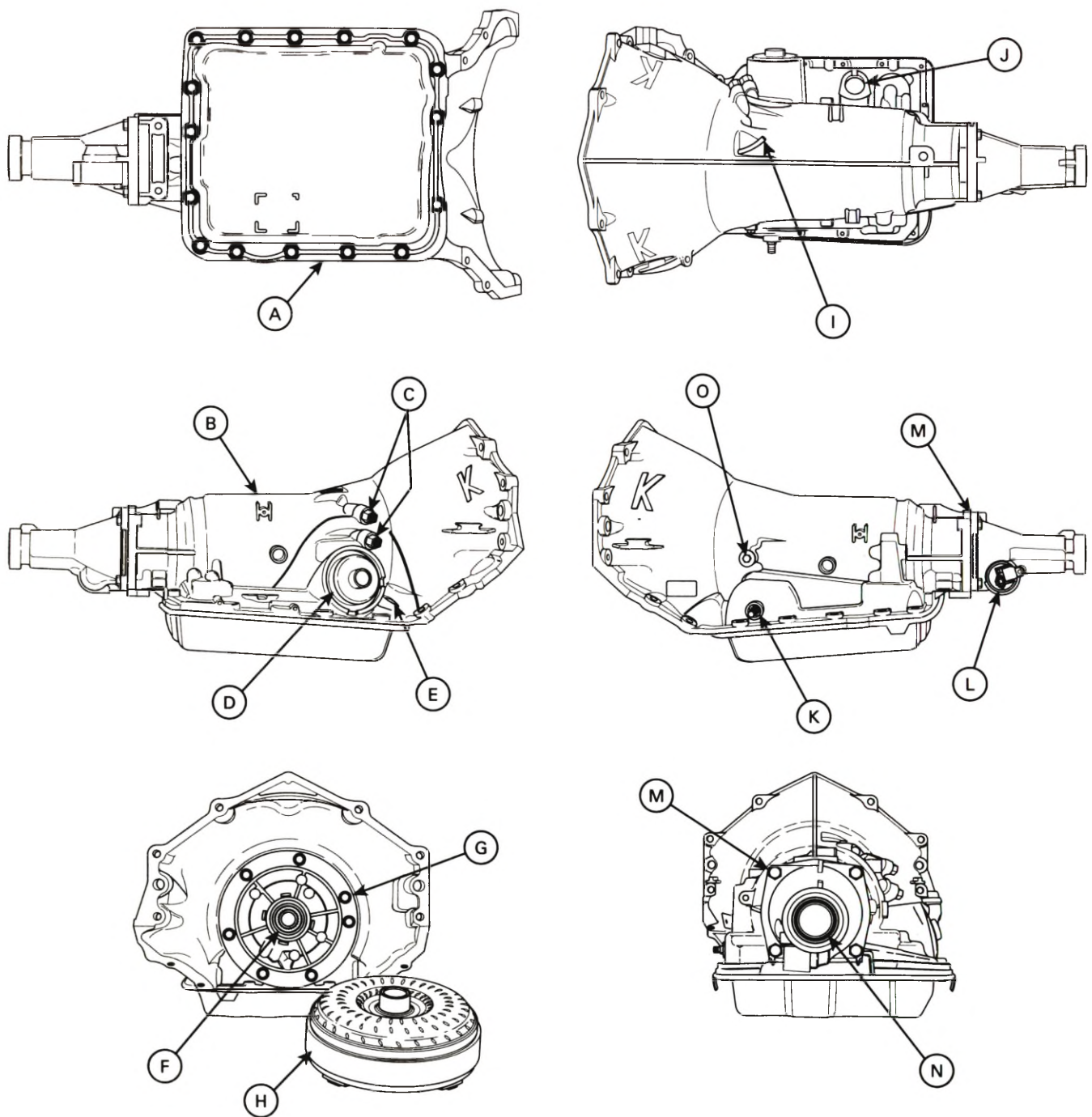
1. Transmission and transmission oil pan:
 - Attaching bolts not torqued correctly.
 - Improperly installed or damaged gasket.
 - Oil pan or mounting face not flat.
2. Case Leak:
 - Filler tube multi-lip seal damaged or missing.
 - Filler tube bracket misaligned.
 - Speed sensor seal damaged.
 - Manual shaft seal damaged.
 - Oil cooler connector fittings loose or damaged.
 - Propeller shaft oil seal worn or damaged.
 - Line pressure pipe plug loose.
 - Porous casting.
3. Leak at converter end:
 - Converter seal damaged.
 - Seal lip cut (check converter hub for damage).
 - Bushing moved forward and damaged.
 - Garter spring missing from seal.
 - Converter leak in weld area.
 - Porous casting (case or pump).
4. Fluid comes out vent pipe or fill tube:
 - Overfilled.
 - Water or coolant in fluid (fluid will appear milky).
 - Case porous.
 - Incorrect fluid level indicator.
 - Plugged vent.
 - Drain back holes plugged.
 - The alignment of the oil pump to case gasket (if equipped).

CASE POROSITY REPAIR

1. Clean the leak area with solvent and air dry.

CAUTION: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Mix a sufficient amount of epoxy adhesive (GM P/N 1052533 or equivalent) following the manufacturer's recommendations.
3. While the transmission case is hot, apply epoxy adhesive with a clean, dry soldering acid brush.
4. Allow the epoxy adhesive to cure for three hours before starting the engine.
5. Repeat fluid leak diagnosis procedures.



A BOTTOM PAN GASKET
 B CASE
 C COOLER CONNECTORS
 D SERVO COVER SEAL
 E OIL FILL TUBE SEAL

F OIL PUMP SEAL ASSEMBLY
 G OIL PUMP TO CASE SEAL
 H CONVERTER
 I VENT
 J ELECTRICAL CONNECTOR SEAL

K MANUAL SHAFT SEAL
 L SPEED SENSOR SEAL
 M EXTENSION TO CASE SEAL
 N EXTENSION OIL SEAL ASSEMBLY
 O LINE PRESSURE PLUG

Figure 43 Leak Inspection Points



PARK - (Engine Running)

With the gear selector lever in the Park (P) position and the engine running, line pressure from the oil pump assembly is directed to various components in the valve body and oil pump.

PRESSURE REGULATION

Pressure Regulator Valve: Regulates oil pump output (line pressure) in response to torque signal fluid pressure, spring force and line pressure acting on the end of the valve. Line pressure is routed through the valve and into both the converter feed and decrease fluid circuits. Regulated line pressure is also directed to the manual valve, converter clutch signal valve and actuator feed limit valve.

Pressure Relief Valve: Controlled by spring force, this checkball limits the maximum value of line pressure. When line pressure reaches this limiting value, fluid is exhausted past the ball and returns to the sump.

Line Pressure Tap: Provides a location to measure line pressure with a fluid pressure gage.

Actuator Feed Limit (AFL) Valve: Biased by spring force and orificed AFL fluid, it limits the maximum value of line pressure entering the AFL fluid circuit. Below this limiting value, AFL fluid pressure equals line pressure. AFL fluid is routed to the pressure control solenoid, 3-2 control solenoid, 1-2 and 2-3 shift solenoids, and the 2-3 shift valve train.

Pressure Control Solenoid: Controlled by the Powertrain Control Module (PCM), it regulates filtered AFL fluid into torque signal fluid pressure. This regulation is controlled by varying the current value to the solenoid in relation to throttle position and other vehicle operating conditions.

TORQUE CONVERTER CLUTCH (TCC)

Torque Converter Clutch Signal Valve: The valve may be in a position to allow line pressure to enter the converter clutch (CC) signal fluid circuit. If this occurs with the 2nd clutch fluid circuit empty, CC signal fluid pressure orificed to the end of the CC signal valve will close the valve and block line pressure. Any fluid in the CC signal fluid circuit will exhaust through the normally open and closed TCC solenoid.

Converter Clutch Apply Valve: Held in the release position by spring force, it directs converter feed fluid into the release fluid circuit. Also, fluid returning from the converter in the apply fluid circuit is routed through the valve and into the cooler fluid circuit.

Torque Converter: Release fluid pressure unseats the TCC apply checkball (#9), keeps the pressure plate released from the converter cover and fills the converter with fluid. Fluid exits the converter between the converter hub and stator shaft in the apply fluid circuit.

Cooler and Lubrication System: Cooler fluid from the converter clutch apply valve is routed through the transmission fluid cooler and into the lubrication fluid circuits.

Manual Valve: Controlled by the selector lever and manual shaft, the manual valve is in the Park (P) position and directs line pressure into the PR (Park/Reverse) fluid circuit. Line pressure is blocked from entering any other fluid circuit at the manual valve.

LO AND REVERSE CLUTCH APPLIES

Lo and Reverse Clutch Piston: PR fluid seats the lo/reverse clutch checkball (#10) and is orificed to the outer area of the piston. Orificing PR fluid around the #10 checkball helps control the lo and reverse clutch apply. Also, lo/reverse fluid pressure from the lo overrun valve acts on the inner area of the lo and reverse clutch piston to increase the clutch holding capacity.

Lo Overrun Valve: PR fluid pressure moves the valve against spring force and fills the lo/reverse fluid circuit. Lo/reverse fluid is orificed (#23) back to the lo/overrun valve to assist PR fluid in moving the valve against spring force. Spring force provides a time delay for PR fluid filling the lo/reverse fluid circuit. Lo/reverse fluid is routed to the inner area of the lo and reverse clutch piston to increase the holding capacity of the clutch.

Pressure Switch Assembly (PSA): The PSA consists of five fluid pressure switches: D2 and D3 are normally closed and D4, Lo and Rev are normally open. All fluid circuits routed to the assembly are empty and the PSA signals the PCM that the transmission is in either Park or Neutral.

Shift Solenoids (1-2 and 2-3): Both shift solenoids, which are normally open, are energized by the PCM and block fluid from exhausting. This maintains AFL fluid pressure at solenoid "B" and signal "A" fluid pressure at the 1-2 solenoid.

Shift Valves (1-2, 2-3 and 3-4): Signal "A" fluid pressure holds the 1-2 shift valve in the downshifted position and the 3-4 shift valve in the upshifted (First and Fourth gear) position. AFL fluid pressure from 2-3 shift solenoid holds the 2-3 shift valve train in the downshifted position.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON*	ON*								APPLIED

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

RH0031-4L60-E

Figure 45 Park - Engine Running (Legend)

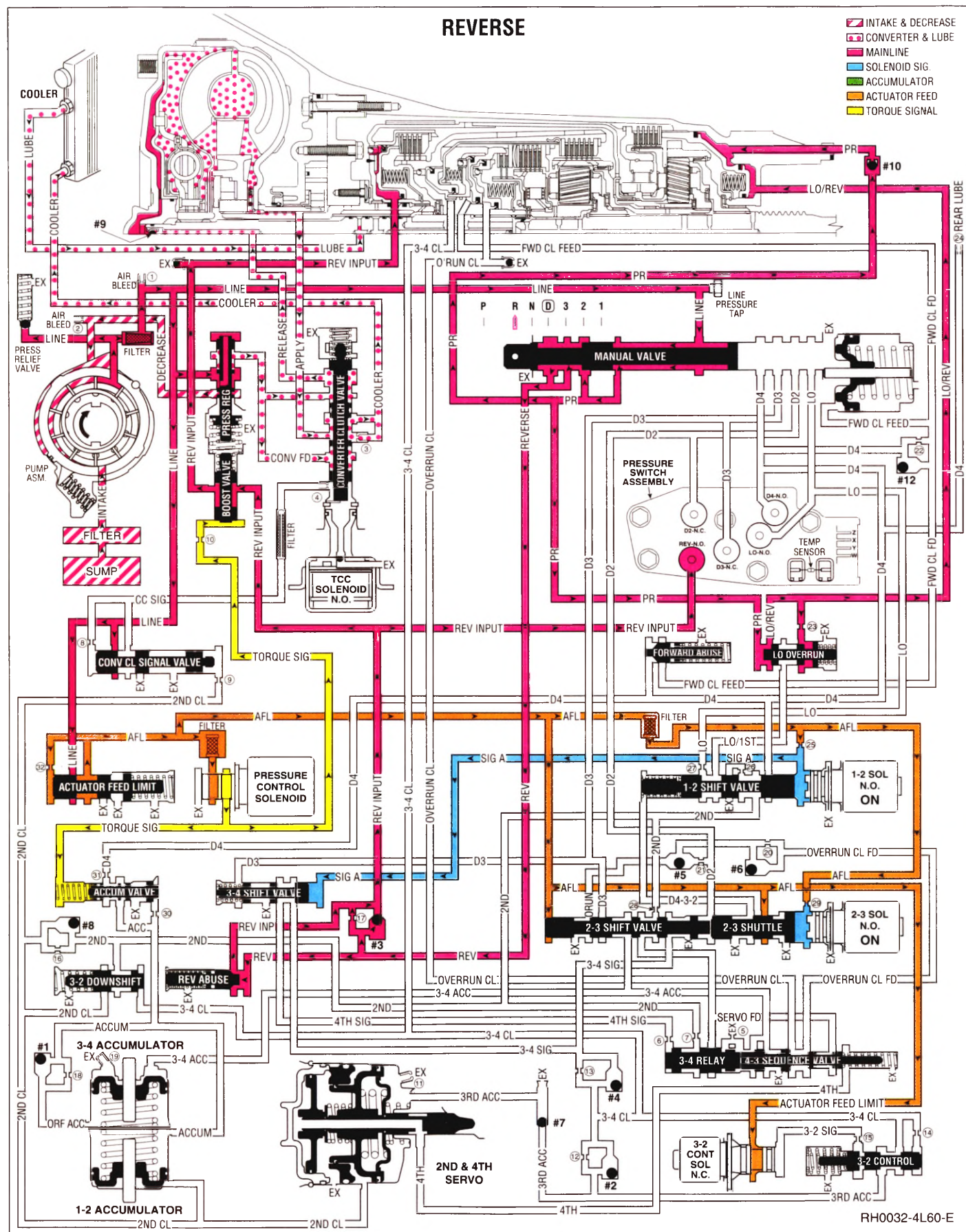


Figure 46 Reverse

REVERSE

When the gear selector lever is moved to the Reverse (R) position (from the Park position), the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve: The manual valve moves to the Reverse position and line pressure enters the reverse fluid circuit. As in Park, line pressure also fills the PR (Park/Reverse) fluid circuit. All other fluid circuits are blocked by the manual valve.

Lo and Reverse Clutch: As in Park, PR fluid pressure acts on the outer area of the lo and reverse clutch piston to apply the lo and reverse clutch. Also, lo/reverse fluid from the lo overrun valve acts on the inner area of the piston to increase the holding capacity of the clutch (see Note Below).

REVERSE INPUT CLUTCH APPLIES

Reverse Input Checkball (#3): Reverse fluid pressure seats the #3 checkball, flows through orifice #17 and fills the reverse input fluid circuit. This orifice helps control the reverse input clutch apply rate when engine speed is at idle.

Reverse Abuse Valve: Reverse fluid pressure acts on the end of the valve opposite of spring force. At engine speeds above idle, reverse fluid pressure, which is fed by line pressure, increases and moves the valve against spring force (as shown). Reverse fluid can then fill the reverse input fluid circuit through the reverse abuse valve. This bypasses the control of orifice #17 and provides a faster clutch apply.

Boost Valve: Reverse input fluid pressure moves the boost valve against the pressure regulator valve spring. The spring acts on the pressure regulator valve to increase the operating range of line pressure in Reverse. Reverse input fluid also flows through the valve and to the reverse input clutch piston. Remember that torque signal fluid pressure continually acts on the boost valve to control line pressure in response to vehicle operating conditions.

Reverse Input Clutch Piston: Reverse input fluid pressure moves the piston to apply the reverse input clutch plates and obtain Reverse.

Reverse Input Air Bleed Checkball: This ball and capsule is located in the reverse input fluid circuit in the oil pump to provide an air escape when the fluid pressure increases. It also allows air into the circuit to displace the fluid when the clutch releases.

Pressure Switch Assembly (PSA): Reverse input fluid pressure closes the normally open reverse switch in the PSA. This signals the PCM that the manual valve is in the Reverse (R) position.

Shift Solenoids (1-2 and 2-3): Both solenoids are energized as in Park range. Signal "A" and actuator feed limit (AFL) fluids are blocked from exhausting through the shift solenoids to maintain fluid pressure in these circuits at the end of the shift valves.

Shift Valves (1-2, 2-3 and 3-4): Signal "A" fluid pressure holds the 1-2 shift valve in the downshifted position and the 3-4 shift valve in the upshifted (First and Fourth gear) position. AFL fluid pressure from shift the 2-3 solenoid holds the 2-3 shift valve train in the downshifted position.

Pressure Control Solenoid: It continues to regulate AFL fluid into torque signal fluid pressure. The PCM varies the current at the solenoid to regulate torque signal fluid pressure in response to throttle position and other PCM input signals. Torque signal fluid pressure is used to control line pressure at the boost and pressure regulator valves.

Note: The explanation in each gear range is, for the most part, limited to what changes from the range on the previous page. However, some component descriptions are repeated for clarity and continuity. Also, refer to the appropriate General Motors Service Manual for specific fluid pressure information.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON*	ON*		APPLIED						APPLIED

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

Figure 47 Reverse (Legend)



Figure 48 Neutral - Engine Running

NEUTRAL - (Engine Running)

When the gear selector lever is moved to the Neutral position (N), from the Reverse position, the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve: In the Neutral position, the manual valve blocks line pressure from entering any other fluid circuits. Reverse and PR fluids exhaust past the manual valve.

LO and REVERSE CLUTCH RELEASES

Lo and Reverse Clutch Piston: PR and lo/reverse fluids exhaust from the piston, thereby releasing the lo and reverse clutch plates. Exhausting PR fluid unseats the lo/reverse checkball (#10) for a quick exhaust.

Lo Overrun Valve: Spring force closes the valve when PR fluid pressure exhausts. Lo/reverse fluid exhausts through the valve, into the lo/1st fluid circuit, past the 1-2 shift valve, into the lo fluid circuit and through an exhaust port at the manual valve.

REVERSE INPUT CLUTCH RELEASES

Reverse Input Clutch Piston: Reverse input fluid pressure exhausts from the piston, through the boost valve, past the #3 checkball and to the manual valve. With reverse input fluid exhausted, the reverse input clutch plates are released and the transmission is in Neutral.

Reverse Abuse Valve: Reverse fluid pressure exhausts and spring force closes the valve.

Boost Valve: Reverse input fluid pressure exhausts and line pressure returns to the normal operating range as in the Park and Overdrive positions.

Reverse Input Checkball (#3): Exhausting reverse input fluid unseats the ball for a quick exhaust through the reverse fluid circuit and past the manual valve.

Pressure Switch Assembly (PSA): Reverse input fluid exhausts from the PSA. With no other fluid routed to it, the PSA signals the PCM that the transmission is operating in either Park or Neutral.

Note: In Park, Reverse, and Neutral the shift solenoids are shown energized. This is the normal operating state when the vehicle is stationary or at low vehicle speeds. However, the PCM will change the shift solenoid states depending on vehicle speed. For example, if Neutral is selected when the transmission is operating in Second Gear, the shift solenoids will remain in a Second Gear state. However, with the manual valve blocking line pressure, the shift solenoid states do not affect transmission operation in Park, Reverse and Neutral.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON*	ON*								

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

Figure 49 Neutral - Engine Running (Legend)



OVERDRIVE RANGE - FIRST GEAR

When the gear selector lever is moved to the Overdrive (D) position, from the Neutral position, the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve: Line pressure flows through the manual valve and fills the D4 fluid circuit. All other fluid circuits remain empty with the manual valve in the Overdrive position.

FORWARD CLUTCH APPLIES

Forward Clutch Accumulator Checkball (#12): D4 fluid pressure seats the ball and is orificed (#22) into the forward clutch feed fluid circuit. This orifice helps control the forward clutch apply rate.

Forward Clutch Piston: Forward clutch feed fluid pressure moves the piston to apply the forward clutch plates and obtain First gear.

Forward Clutch Accumulator Piston: Forward clutch feed fluid pressure moves the piston against spring force. This action absorbs some of the initial increase of forward clutch feed fluid pressure to cushion the forward clutch apply.

Forward Clutch Abuse Valve: D4 fluid pressure acts on the valve opposite of spring force. At engine speeds greater than idle, D4 fluid pressure increases and moves the valve against spring force (as shown). D4 fluid can then quickly fill the forward clutch feed fluid circuit, thereby bypassing the control of orifice #22 and providing a faster apply of the forward clutch. Otherwise, with increased throttle opening and engine torque, the clutch may slip during apply.

Pressure Switch Assembly (PSA): D4 fluid pressure is routed to the PSA and closes the normally open D4 fluid pressure switch. This signals the PCM that the transmission is operating in Overdrive range.

1-2 Shift Solenoid: Energized (ON) as in Neutral, the normally open solenoid is closed and blocks signal "A" fluid from exhausting through the solenoid. This maintains pressure in the signal "A" fluid circuit.

2-3 Shift Solenoid: Energized (ON) as in Neutral, the normally open solenoid is closed and blocks actuator feed limit (AFL) fluid from exhausting through the solenoid. This maintains AFL fluid pressure at the solenoid end of the 2-3 shift valve.

2-3 Shift Valve Train: AFL fluid pressure at the solenoid end of the 2-3 shift valve holds the valve train in the downshifted position against AFL fluid pressure acting on the 2-3 shuttle valve. In this position, the 2-3 shift valve blocks AFL fluid from entering the D432 fluid circuit. The D432 fluid circuit is open to an exhaust port past the valve.

1-2 Shift Valve: Signal "A" fluid pressure holds the valve in the downshifted position against spring force. In the First gear position the valve blocks D4 fluid from entering the 2nd fluid circuit.

Accumulator Valve: Biased by torque signal fluid pressure, spring force and orificed accumulator fluid pressure at the end of the valve, the accumulator valve regulates D4 fluid into accumulator fluid pressure. Accumulator fluid is routed to both the 1-2 and 3-4 accumulator assemblies in preparation for the 1-2 and 3-4 upshifts respectively.

Rear Lube: D4 fluid is routed through an orifice cup plug (#24) in the rear of the transmission case to feed the rear lube fluid circuit.

Pressure Control Solenoid: Remember that the pressure control solenoid continually varies torque signal fluid pressure in relation to throttle position and vehicle operating conditions. This provides a precise control of line pressure.

3-2 Control Solenoid: The PCM keeps the solenoid OFF in First gear and the normally closed solenoid blocks AFL fluid from entering the 3-2 signal fluid circuit.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRIDE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3				APPLIED	HOLDING		HOLDING	
ON	ON								

Figure 51 Overdrive Range - First Gear (Legend)



OVERDRIVE RANGE - SECOND GEAR

As vehicle speed increases, and other operating conditions are appropriate, the PCM de-energizes the 1-2 shift solenoid to shift the transmission into Second gear.

1-2 Shift Solenoid: De-energized (turned OFF) by the PCM, the normally open solenoid opens and signal "A" fluid exhausts through the solenoid.

Note: Actuator feed limit (AFL) fluid continues to feed the signal "A" fluid circuit through orifice #25. However, the exhaust port through the solenoid is larger than orifice #25 to prevent a pressure buildup in the signal "A" fluid circuit. Exhausting signal "A" fluid is represented by the blue arrows.

2-3 Shift Solenoid: Energized (ON) as in First gear, it blocks AFL fluid from exhausting through the solenoid. This maintains AFL fluid pressure at the solenoid end of the 2-3 shift valve.

2-4 BAND APPLIES

1-2 Shift Valve: Without signal "A" fluid pressure, spring force moves the valve into the upshifted position. D4 fluid is routed through the valve and fills the 2nd fluid circuit.

1-2 Shift Checkball (#8): 2nd fluid pressure seats the #8 checkball, flows through orifice #16 and fills the 2nd clutch fluid circuit. This orifice helps control the 2-4 band apply rate.

2-4 Servo Assembly: 2nd clutch fluid pressure moves the 2nd apply piston against servo cushion and servo return spring forces. The apply piston moves the band apply pin to apply the 2-4 band. These spring forces help control the 2-4 band apply rate.

1-2 Accumulator: 2nd clutch fluid pressure also moves the 1-2 accumulator piston against spring force and accumulator fluid pressure. This action absorbs initial 2nd clutch fluid pressure to cushion the 2-4 band apply rate. Also, the movement of the 1-2 accumulator piston forces some accumulator fluid out of the accumulator assembly. This accumulator fluid is routed back to the accumulator valve.

Accumulator Valve: Accumulator fluid forced out of the 1-2 accumulator is orificed (#30) to the end of the accumulator valve. This pressure moves the valve against spring force and torque signal fluid pressure to regulate the exhaust of excess accumulator fluid. This regulation provides additional control for the 2-4 band apply rate. The oil circuit shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.

2-3 Shift Valve Train: AFL fluid pressure from the 2-3 shift solenoid holds the valve train in the downshifted position. 2nd fluid is routed through the 2-3 shuttle valve and fills the servo feed fluid circuit.

3-4 Relay Valve and 4-3 Sequence Valve: Spring force holds these valves in the downshifted position (First, Second and Third gear position). 2nd fluid is blocked by the 3-4 relay valve and servo feed fluid is blocked by both valves in preparation for a 3-4 upshift.

3-2 Downshift Valve: Spring force holds the valve closed, blocking 2nd fluid and 2nd clutch fluid. This valve is used to help control the 3-2 downshift.

3-2 Control Solenoid: In Second gear, the PCM operates the normally closed solenoid at approximately a 90% duty cycle. This opens the AFL fluid circuit to fill the 3-2 signal fluid circuit (at 100% duty cycle the AFL fluid circuit is completely open).

3-2 Control Valve: 3-2 signal fluid pressure moves the valve against spring force. This action does not affect the transmission operation in Second gear.

3-4 Shift Valve: Signal "A" fluid pressure exhausts and spring force moves the valve into the downshift position (Second and Third gear position).

TORQUE CONVERTER CLUTCH

Converter Clutch Signal Valve: 2nd clutch fluid pressure opens the valve and line pressure feeds the converter clutch (CC) signal fluid circuit. CC signal fluid is orificed (#8) to the end of the CC signal valve and opposes 2nd clutch fluid pressure. CC signal fluid is routed through a filter and orificed (#4) to the TCC solenoid.

TCC Solenoid: Under normal operating conditions in Second gear the PCM keeps the normally open TCC solenoid de-energized (OFF). CC signal fluid exhausts through the open solenoid and spring force keeps the converter clutch apply valve in the release position.

Note: The orifice cup plug (#4) in the CC signal fluid circuit is smaller than the exhaust through the TCC solenoid. Therefore, fluid pressure does not build up at the end of the converter clutch apply valve.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	ON	APPLIED			APPLIED	HOLDING			

Figure 53 Overdrive Range - Second Gear (Legend)



OVERDRIVE RANGE - THIRD GEAR

As vehicle speed increases further, and other vehicle operating conditions are appropriate, the PCM de-energizes the normally open the 2-3 shift solenoid to shift the transmission into Third gear.

2-3 Shift Solenoid: De-energized (turned OFF) by the PCM, the solenoid opens and actuator feed limit (AFL) fluid exhausts through the solenoid.

Note: AFL fluid continues to feed the solenoid through orifice #29. However, the exhaust port through the solenoid is larger than orifice #29 to prevent a buildup of pressure in the AFL fluid circuit at the solenoid end of the 2-3 shift valve. Exhausting AFL fluid is represented by the arrows through the solenoid.

3-4 CLUTCH APPLIES

2-3 Shift Valve Train: AFL fluid pressure at the 2-3 shuttle valve moves the valve train toward the solenoid. In the upshifted position the following changes occur:

- AFL fluid is routed through the 2-3 shift valve and fills the D432 fluid circuit.
- 2nd fluid is blocked from entering the servo feed fluid circuit and is orificed (#28) into the 3-4 signal fluid circuit. This orifice helps control the 3-4 clutch apply rate.
- Servo feed fluid exhausts past the valve, into the 3-4 accumulator fluid circuit and through an exhaust port at the 3-4 relay valve.

3-4 Clutch Exhaust Checkball (#4): 3-4 signal fluid unseats the ball and enters the 3-4 clutch fluid circuit.

3-4 Clutch Piston: 3-4 clutch fluid pressure moves the piston to apply the 3-4 clutch plates and obtain 3rd gear. However, the 2-4 band must release as the 3-4 clutch applies.

2-4 BAND RELEASES and

3-4 CLUTCH ACCUMULATION

3rd Accumulator Checkball (#2): 3-4 clutch fluid pressure unseats the ball and fills the 3rd accumulator fluid circuit.

3rd Accumulator Exhaust Checkball (#7): 3rd accumulator fluid seats the ball against the orificed exhaust and is routed to the release side of the 2nd apply piston. Before the #7 checkball seats, air in the 3rd accumulator fluid circuit is exhausted through the orifice.

2-4 Servo Assembly: 3rd accumulator fluid pressure acts on the release side of the 2nd apply piston and assists servo return spring force. The surface area on the release side of the piston is greater than the surface area on the apply side. Therefore, 3rd accumulator fluid pressure and servo return

spring force move the 2nd apply piston against 2nd clutch fluid pressure. This action serves two functions:

1. Move the apply pin to release the 2-4 band.
2. Act as an accumulator by absorbing initial 3-4 clutch fluid to cushion the 3-4 clutch apply rate. Remember that the 3rd accumulator fluid circuit is fed by 3-4 clutch fluid.

3-2 Downshift Valve: 3-4 clutch fluid pressure moves the valve against spring force. This opens the valve and allows 2nd fluid to feed the 2nd clutch fluid circuit through the valve.

3-2 Control Solenoid and 3-2 Control Valve: The solenoid remains at approximately 90% duty cycle and routes AFL fluid into the 3-2 signal fluid circuit. 3-2 signal fluid pressure holds the 3-2 control valve against spring force, thereby blocking the 3rd accumulator and 3-4 clutch fluid circuits.

1-2 Shift Solenoid and 1-2 Shift Valve: The 1-2 shift solenoid remains de-energized and signal "A" fluid is exhausted through the solenoid. Also, D432 fluid pressure from the 2-3 shift valve assists spring force to hold the 1-2 shift valve in the upshifted position.

3-4 Shift Valve: Spring force holds the valve in the downshifted position, blocking 3-4 clutch fluid in preparation for a 3-4 upshift.

TORQUE CONVERTER CLUTCH

TCC Solenoid: Under normal operating conditions in Overdrive Range - Third Gear the PCM keeps the normally open TCC solenoid de-energized. CC signal fluid exhausts through the open solenoid and spring force keeps the converter clutch apply valve in the release position. However, at speeds above approximately 121 km/h (75 mph) the PCM will command TCC apply in Third gear.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRIDE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	OFF				APPLIED	HOLDING	APPLIED		

Figure 55 Overdrive Range - Third Gear (Legend)



OVERDRIVE RANGE - FOURTH GEAR

Converter Clutch Applied

At higher vehicle speeds, the Hydra-matic 4L60-E transmission uses an Overdrive gear ratio (Fourth gear) to increase fuel economy and maximize engine performance. When vehicle operating conditions are appropriate, the PCM energizes the 1-2 shift solenoid to shift the transmission into Fourth gear.

1-2 Shift Solenoid: Energized (turned ON) by the PCM, the normally open solenoid closes and blocks signal "A" fluid from exhausting through the solenoid. This creates pressure in the signal "A" fluid circuit.

2-3 Shift Solenoid: De-energized (OFF) as in Third gear, it exhausts actuator feed limit (AFL) fluid through the solenoid.

1-2 Shift Valve: D432 fluid pressure from the 2-3 shift valve and spring force hold the valve in the upshifted position against signal "A" fluid pressure.

2-4 BAND APPLIES

3-4 Shift Valve: Signal "A" fluid pressure moves the valve into the upshifted position against spring force. In this position, the valve routes 3-4 signal fluid into the 4th signal fluid circuit.

3-4 Relay Valve and 4-3 Sequence Valve: 4th signal fluid pressure moves both valves into the upshifted (Fourth gear) position against spring force acting on the 4-3 sequence valve. This causes the following changes:

- Orificed (#7) 2nd fluid is routed through the 3-4 relay valve and into the servo feed fluid circuit.
- Servo feed fluid is routed through the 4-3 sequence valve and into the 4th fluid circuit.
- 3-4 accumulator fluid routed from the 2-3 shuttle valve is blocked by both valves.

2-4 Servo Assembly: 4th fluid is routed through the center of the servo pin and acts on the apply side of the 4th apply piston. 4th fluid pressure moves the 4th apply piston against the apply pin spring force acting on the release side of the 4th apply piston. This action moves the apply pin and applies the 2-4 band to obtain Fourth gear.

2-4 BAND APPLY ACCUMULATION

2-3 Shift Valve Train: The valve train remains in the upshifted position with AFL fluid pressure acting on the 2-3 shuttle valve. In addition to its operation in Third gear, the 2-3 shift valve directs servo feed fluid into the 3-4 accumulator fluid circuit.

3-4 Accumulator Assembly: 3-4 accumulator fluid pressure moves the 3-4 accumulator piston against spring force and orificed accumulator fluid pressure. This action absorbs initial 4th clutch apply fluid pressure to cushion the 2-4 band apply. Remember that both the 3-4 accumulator and 4th fluid circuits are fed by servo feed fluid. As 3-4 accumulator fluid fills the accumulator, any air in the system will exhaust through orifice #19. The piston movement forces some orificed accumulator fluid out of the 3-4 accumulator assembly.

3-4 Accumulator Checkball (#1): The accumulator fluid forced from the accumulator unseats the #1 checkball and enters the accumulator fluid circuit. This fluid is routed to the accumulator valve. This is shown by the arrow directions in the oil circuit.

Accumulator Valve: Accumulator fluid forced from the 3-4 accumulator is orificed to the end of the accumulator valve. This fluid pressure, in addition to spring force and torque signal fluid pressure, regulates the exhaust of excess accumulator fluid pressure through the middle of the valve. This regulation helps control the 2-4 band apply feel.

3-2 Control Solenoid and 3-2 Control Valve: Similar to Third gear, the PCM operates the solenoid at approximately a 90% duty cycle, AFL fluid fills the 3-2 signal fluid circuit and 3-2 signal fluid pressure holds the 3-2 control valve against spring force.

TORQUE CONVERTER CLUTCH APPLIES

TCC Solenoid: When operating conditions are appropriate, the PCM energizes the normally open TCC solenoid. This closes the solenoid, blocks converter clutch signal fluid from exhausting and creates pressure in the converter clutch signal fluid circuit.

Converter Clutch Apply Valve: Converter clutch signal fluid pressure moves the valve against spring force and into the apply position. In this position, release fluid is open to an exhaust port and converter feed fluid fills the apply fluid circuit. Converter feed fluid also feeds the cooler fluid circuit through orifice #3.

Torque Converter: Release fluid from behind the pressure plate exhausts through the end of the turbine shaft. Apply fluid pressure is routed between the converter hub and stator shaft where it enters the torque converter. This fluid applies the converter clutch against the converter cover and keeps the converter filled with fluid.

TCC Apply Checkball (#9): Release fluid exhausting from the converter seats the #9 checkball, located in the end of the turbine shaft, and is orificed around the ball. Orificing the exhausting release fluid controls the converter clutch apply rate.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON	OFF	APPLIED			APPLIED		APPLIED		

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Figure 57 Overdrive Range - Fourth Gear – Converter Clutch Applied (Legend)



OVERDRIVE RANGE: 4-3 DOWNSHIFT

When the transmission is operating in Fourth gear, a forced 4-3 downshift will occur if there is a significant increase in throttle position. At minimum throttle, vehicle speed will decrease gradually (coastdown) and the PCM will command a 4-3 downshift. The PCM will also initiate a forced 4-3 downshift when throttle position remains constant but engine load is increased, such as driving up a steep incline. To achieve a 4-3 downshift, the PCM de-energizes the 1-2 shift solenoid and the following changes occur to the transmissions electrical and hydraulic systems:

1-2 Shift Solenoid: De-energized by PCM, the normally open solenoid opens and signal "A" fluid exhausts through the solenoid.

1-2 Shift Valve: As in Fourth gear, D432 fluid pressure and spring force hold the valve in the upshifted position.

2-4 BAND RELEASES

3-4 Shift Valve: With signal "A" fluid pressure exhausted, spring force moves the valve into the downshifted position. In this position, the valve blocks 3-4 signal fluid and 4th signal fluid exhausts past the valve.

3-4 Relay Valve and 4-3 Sequence Valve: These valves control the timing of the 2-4 band release. With 4th signal fluid pressure exhausted, 3-4 accumulator fluid pressure moves the 3-4 relay valve into the Third gear position. This opens 3-4 accumulator fluid to an orificed exhaust (#5) past the 3-4 relay valve (shown by red arrows). Because the exhaust is orificed, 3-4 accumulator fluid pressure momentarily holds the 4-3 sequence valve against spring force before completely exhausting.

When exhausting 3-4 accumulator fluid pressure decreases sufficiently, spring force will move the 4-3 sequence valve into the Third gear position as shown. This opens both the 3-4 accumulator and 4th fluid circuits to a quick exhaust past the 4-3 sequence valve. In this position the valve blocks 2nd fluid from entering the servo feed fluid circuit.

2-4 Servo Assembly: 4th fluid exhausts from the 4th apply piston in the servo assembly. The apply pin spring moves the 4th apply piston and apply pin to release the band from the reverse input drum and shift the transmission into Third gear.

3-4 Accumulator Assembly: 3-4 accumulator fluid exhausts from the 3-4 accumulator piston. Orificed accumulator fluid pressure and spring force move the piston to a Third gear position.

3-4 Accumulator Checkball (#1): As accumulator fluid fills the 3-4 accumulator it seats the #1 checkball and is forced through orifice #18. This orifice controls the rate at which accumulator fluid pressure fills the 3-4 accumulator and 3-4 accumulator fluid exhausts from the accumulator assembly.

Accumulator Valve: Biased by torque signal fluid pressure and spring force, the accumulator valve regulates drive fluid into the accumulator fluid circuit.

2-3 Shift Solenoid: This solenoid remains de-energized as in Fourth gear and AFL fluid exhausts through the solenoid.

2-3 Shift Valve Train: AFL fluid pressure at the 2-3 shuttle valve holds the valves in the upshifted position. This allows servo feed fluid to exhaust through the valve, into the 3-4 accumulator fluid circuit and past the 4-3 sequence valve.

Torque Converter Clutch: The PCM releases the converter clutch prior to initiating the 4-3 downshift. However, if vehicle speed is above approximately 121 km/h (75 mph), the PCM will command TCC apply in Third gear.

Pressure Control Solenoid: Remember that the force motor continually adjusts torque signal fluid pressure in relation to the various PCM input signals (mainly throttle position).

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	OFF				APPLIED	HOLDING	APPLIED		

Figure 59 Overdrive Range – 4-3 Downshift (Legend)

OVERDRIVE RANGE: 3-2 DOWNSHIFT

Similar to a forced 4-3 downshift, a forced 3-2 downshift can occur due to minimum throttle (coastdown conditions), heavy throttle or increased engine load. To achieve a forced 3-2 downshift, the PCM energizes the 2-3 shift solenoid and the following changes occur:

2-3 Shift Solenoid: Energized by the PCM, the normally open solenoid closes and blocks actuator feed limit (AFL) fluid from exhausting through the solenoid. This creates pressure in the AFL fluid circuit at the solenoid end of the 2-3 shift valve.

2-3 Shift Valve Train: AFL fluid pressure from the shift solenoid moves both valves to the downshifted position against AFL fluid pressure acting on the 2-3 shuttle valve. This causes the following changes:

- AFL fluid is blocked from the D432 fluid circuit and D432 fluid exhausts past the 2-3 shift valve.
- 2nd fluid is blocked from feeding the 3-4 signal fluid circuit and 2nd fluid is routed into the servo feed fluid circuit.
- 3-4 signal fluid is exhausted past the valve. 3-4 clutch fluid and 3rd accumulator fluid, which were fed by 3-4 signal fluid, also exhaust.

3-4 CLUTCH RELEASES and 2-4 BAND APPLIES

3-4 Clutch Piston: 3-4 clutch fluid exhausts from the piston and the 3-4 clutch plates are released.

3-4 Clutch Exhaust Checkball (#4): Exhausting 3-4 clutch fluid seats the #4 checkball and is forced through orifice #13. This orifice controls 3-4 clutch fluid exhaust and the 3-4 clutch release rate.

2-4 Servo Assembly: 3rd accumulator fluid exhausts from the servo assembly. 2nd clutch fluid pressure moves the 2nd apply piston against servo return spring force to move the apply pin and apply the 2-4 band.

3-2 Downshift Valve and 1-2 Upshift Checkball (#8): 3-4 clutch fluid exhausts from the valve and spring force moves the valve into the Second gear position. However, before spring force overcomes exhausting 3-4 clutch fluid pressure, 2nd fluid feeds the 2nd clutch fluid circuit through the valve. This bypasses the control of orifice #16 at the #8 checkball and provides a faster 2-4 band apply. Remember that the #8 checkball and orifice #16 are used to help control the 2-4 band apply during a 1-2 upshift.

DOWNSHIFT TIMING and CONTROL

At higher vehicle speeds the 2-4 band apply must be delayed to allow engine speed RPM to increase sufficiently for a smooth transfer of engine load to the 2-4 band. Therefore, exhaust of 3rd accumulator fluid must be delayed. However, at lower speeds the band must be applied quickly. To provide for the varying requirements for the 2-4 band apply rate,

exhausting 3rd accumulator fluid is routed to both the 3rd accumulator checkball (#2) and the 3-2 control valve.

3rd Accumulator Checkball (#2): Exhausting 3rd accumulator fluid seats the #2 ball and is forced through orifice #12. This fluid exhausts through the 3-4 clutch and 3-4 signal fluid circuits and past the 2-3 shuttle valve. Orifice #12 slows the exhaust of 3rd accumulator fluid and delays the 2-4 band apply rate.

Note: The #12 orifice is not used on some models. For these models, all of the exhausting 3rd accumulator fluid is routed to the 3-2 control valve when the #2 checkball seats.

3-2 Control Solenoid and 3-2 Control Valve: These components are used to increase the exhaust rate of 3rd accumulator fluid; as needed depending on vehicle speed. The normally closed 3-2 control solenoid is Pulse Width Modulated (PWM) and controlled by the PCM through a duty cycle operation. The PCM decreases the solenoid's duty cycle during a 3-2 downshift from approximately 90% to as low as 10%. Once the shift is complete the solenoid returns to a 90% duty cycle. The duty cycle value during the shift controls the 2-4 band apply rate.

- At lower vehicle speed the PCM operates the 3-2 control solenoid at a lower duty cycle during the shift.
- At a lower duty cycle the solenoid regulates 3-2 signal fluid to a lower pressure.
- With lower 3-2 signal fluid pressure, 3-2 control valve spring force opens the valve farther to regulate a faster exhaust of 3rd accumulator fluid into the 3-4 clutch fluid circuit (as shown).
- A faster exhaust of 3rd accumulator exhaust provides a faster apply of the 2-4 band, as needed at lower speeds.

3rd Accumulator Exhaust Checkball (#7): After the downshift is completed, the #7 checkball unseats and allows residual fluid in the 3rd accumulator fluid circuit to exhaust.

Pressure Control Solenoid: Remember that the pressure control solenoid continually adjusts torque signal fluid in relation to the various PCM input signals (mainly throttle position).

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	ON	APPLIED			APPLIED	HOLDING			

RH0047-4L60-E

Figure 61 Overdrive Range – 3-2 Downshift (Legend)



DRIVE RANGE - MANUAL THIRD (from Overdrive Range - Fourth Gear)

A manual 4-3 downshift is available to increase vehicle performance when the use of only three gear ratios is desired. Manual Third gear range also provides engine braking in Third gear when the throttle is released. A manual 4-3 downshift is accomplished by moving the selector lever into the Manual Third (D) position. This moves the manual valve and immediately downshifts the transmission into Third gear. Refer to *Overdrive Range: 4-3 Downshift* for a complete description of a 4-3 downshift. In Manual Third, the transmission is prevented, both hydraulically and electronically, from shifting into Fourth gear. The following information explains the additional changes during a manual 4-3 downshift as compared to a forced 4-3 downshift.

Manual Valve: The selector lever moves the manual shaft and manual valve into the Manual Third position (D). This allows line pressure to enter the D3 fluid circuit.

Pressure Switch Assembly (PSA): D3 fluid is routed to the PSA and opens the normally closed D3 fluid pressure switch. The combination of the opened D3 switch and the closed D4 switch signals the PCM that the transmission is operating in Manual Third.

FOURTH GEAR PREVENTED

1-2 Shift Solenoid: When Manual Third is selected, the PCM de-energizes the 1-2 shift solenoid to immediately downshift the transmission into Third gear. This electronically prevents Fourth gear.

3-4 Shift Valve: D3 fluid pressure assists spring force to keep the valve in the downshifted position against the signal "A" fluid circuit. In this position the valve blocks 3-4 signal fluid and the 4th signal fluid circuit is open to an exhaust port past the valve. Therefore, with D3 fluid pressure assisting spring force, Fourth gear is hydraulically prevented.

OVERRUN CLUTCH APPLIED

2-3 Shift Valve Train: With the 2-3 shift solenoid de-energized and open, actuator feed limit (AFL) fluid acting on the 2-3 shuttle valve holds both valves in the upshifted position. This allows D3 fluid to feed the overrun fluid circuit through the 2-3 shuttle valve.

Overrun Clutch Feed Checkball (#5): Overrun fluid pressure seats the ball against the empty D2 fluid circuit.

Overrun Clutch Control Checkball (#6): Overrun fluid pressure seats the #6 checkball and is orificed (#20) to fill the overrun clutch feed fluid circuit. This orifice controls the overrun clutch apply rate.

3-4 Relay Valve and 4-3 Sequence Valve: 4th signal fluid pressure is exhausted from the end of the 3-4 relay valve. Overrun clutch feed fluid pressure assists spring force and closes both valves. This allows overrun clutch feed fluid to flow through the 4-3 sequence valve and fill the overrun clutch fluid circuit.

Overrun Clutch Piston: Overrun clutch fluid pressure moves the piston to apply the overrun clutch plates. The overrun

clutch plates provide engine compression braking in Manual Third - Third Gear.

Overrun Clutch Air Bleed Checkball: This ball and capsule is located in the overrun clutch fluid circuit in the oil pump. It allows air to exhaust from the circuit as fluid pressure increases and also allows air into the circuit to displace the fluid when the clutch releases.

Torque Converter Clutch: The PCM de-energizes the TCC solenoid to release the converter clutch prior to downshifting (assuming the converter clutch is applied in Overdrive Range - Fourth Gear when Manual Third is selected). The PCM will re-apply the converter clutch in Manual Third - Third Gear only when vehicle speed is above approximately 121 km/h (75 mph).

Pressure Control Solenoid: The pressure control solenoid operates in the same manner as Overdrive Range, regulating in response to throttle position and other vehicle operating conditions.

MANUAL THIRD - FIRST and SECOND GEARS: OVERRUN CLUTCH RELEASED

In Manual Third the transmission upshifts and downshifts normally between First, Second and Third gears. However, in First and Second gears, the 2-3 shift solenoid is energized and the 2-3 shift valve train is in the downshifted position. The 2-3 shuttle valve blocks D3 fluid from entering the overrun fluid circuit and opens the overrun fluid circuit to an exhaust port at the valve. This prevents overrun clutch apply and engine compression braking in Manual Third - First and Second Gears.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	OFF			APPLIED	APPLIED	HOLDING	APPLIED		

Figure 63 Manual Third (Legend)



MANUAL SECOND - SECOND GEAR (from Manual Third - Third Gear)

A manual 3-2 downshift can be accomplished by moving the gear selector lever into the Manual Second (2) position when the transmission is operating in Third gear. This causes the transmission to shift immediately into Second gear regardless of vehicle operating conditions. Refer to *Overdrive Range: 3-2 Downshift* for a complete description of a 3-2 downshift. Also, the transmission is prevented from operating in any other gear, First, Third or Fourth. The following information explains the additional changes during a manual 3-2 downshift as compared to a forced 3-2 downshift.

Manual Valve: The selector lever moves the manual shaft and manual valve into the Manual Second (2) position. This allows line pressure to enter the D2 fluid circuit.

Pressure Switch Assembly (PSA): D2 fluid is routed to the PSA where it opens the normally closed D2 fluid pressure switch. With the D2, and D3 pressure switches closed and the D4 pressure switch open, the PSA signals the PCM that the transmission is operating in Manual Second.

THIRD and FOURTH GEARS PREVENTED

2-3 Shift Solenoid: The PCM energizes the 2-3 shift solenoid and AFL fluid pressure holds the 2-3 shift valve in the downshifted position. This electronically prevents Third and Fourth gears.

2-3 Shift Valve Train: D2 fluid is routed between the 2-3 shuttle and 2-3 shift valves and causes the following:

- Regardless of operating conditions, D2 fluid pressure holds the 2-3 shuttle valve in the downshifted position against AFL fluid pressure.
- 2nd fluid is blocked from entering the 3-4 signal fluid circuit and the 3-4 signal fluid circuit is open to an exhaust port at the valve.
- The 3-4 clutch cannot apply with 3-4 signal fluid exhausted. Therefore, Third and Fourth gears are hydraulically prevented.
- 2nd fluid feeds the servo feed fluid circuit but has no function in Manual Second.
- AFL fluid is blocked by the 2-3 shift valve and the D432 fluid circuit is exhausted through the valve.
- Overrun fluid is exhausted through the 2-3 shuttle valve.

1-2 Shift Valve: The 1-2 solenoid is OFF, signal "A" fluid exhausts through the solenoid and spring force holds the valve in the upshifted position.

FIRST GEAR PREVENTED

The prevention of First gear is controlled electronically by the PCM through the 1-2 shift solenoid. The PCM keeps the 1-2 shift solenoid de-energized regardless of vehicle operating conditions when the PSA signals Manual Second gear range. This keeps signal "A" fluid exhausted and spring force holds the 1-2 shift valve in the upshifted position.

OVERRUN CLUTCH REMAINS APPLIED

Overrun Clutch Feed Checkball (#5): Orificed D2 fluid pressure seats the #5 checkball against the empty overrun clutch fluid circuit. This is done simultaneously with overrun clutch fluid exhausting such that there is a continuous fluid supply to the overrun clutch feed fluid circuit.

Overrun Clutch Piston: A continuous supply of fluid pressure is routed to the piston to keep the overrun clutch plates applied.

Torque Converter Clutch: The converter clutch is released prior to downshifting into Manual Second - Second Gear. Under normal operating conditions the TCC will not apply in Second gear.

Pressure Control Solenoid: The PCM output signal to the force motor increases the operating range of torque signal fluid pressure in Manual Second. This provides increased line pressure for the additional torque requirements during engine compression braking and increased engine loads.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	ON	APPLIED		APPLIED	APPLIED	HOLDING			

Figure 65 Manual Second (Legend)

MANUAL FIRST - FIRST GEAR (from Manual Second - Second Gear)

A manual 2-1 downshift can be accomplished by moving the gear selector lever into the Manual First (1) position when the transmission is operating in Second gear. The downshift to First gear is controlled electronically by the PCM. The PCM will not energize the 1-2 shift solenoid to initiate the downshift until vehicle speed is below approximately 48 to 56 km/h (30 to 35 mph). Above this speed, the transmission will operate in a Manual First - Second Gear state. The following text explains the manual 2-1 downshift.

Manual Valve: The selector lever moves the manual shaft and manual valve into the Manual First (1) position. This allows line pressure to enter the lo fluid circuit.

Pressure Switch Assembly (PSA): Lo fluid is routed to the PSA where it closes the normally open lo pressure switch. The addition of the lo pressure switch being closed signals the PCM that Manual First is selected.

2-3 Shift Solenoid: In both First and Second gears this solenoid is energized and maintaining actuator feed limit (AFL) fluid pressure at the solenoid end of the 2-3 shift valve train.

2-3 Shift Valve Train: Held in the downshifted position by AFL fluid pressure from the solenoid, the valve train blocks AFL fluid from entering the D432 fluid circuit. The D432 fluid circuit is open to an exhaust past the valve.

1-2 Shift Solenoid: Below approximately 48 to 56 km/h (30 to 35 mph) the PCM energizes the normally open solenoid. This blocks signal "A" fluid pressure from exhausting through the solenoid and creates pressure in the signal "A" fluid circuit. Above this speed, the PCM keeps the solenoid de-energized and the transmission operates in Manual First - Second Gear.

1-2 Shift Valve: Signal "A" fluid pressure moves the valve against spring force and into the downshifted position. In this position, lo fluid from the manual valve is routed into the lo-1st fluid circuit and D4 fluid is blocked from entering the 2nd fluid circuit. 2nd fluid exhausts through an orifice and an annulus exhaust port past the valve. This orifice (#26) helps control the 2-4 band release during a 2-1 downshift.

2-4 BAND RELEASES

2-4 Servo Assembly: 2nd clutch fluid, which was fed by 2nd fluid, exhausts from the servo. This allows spring force from the servo cushion and servo return springs to move the 2nd apply piston and apply pin to release the 2-4 band. These spring forces help control the 2-4 band release.

1-2 Accumulator Assembly: 2nd clutch fluid also exhausts from the 1-2 accumulator assembly. Spring force and accumulator fluid pressure move the accumulator piston to assist 2nd clutch fluid exhaust.

Accumulator Valve: As accumulator fluid is filling the 1-2 accumulator assembly, the accumulator valve regulates D4 fluid into the accumulator fluid circuit. This regulation, biased by torque signal fluid pressure and spring force, helps

control the movement of the 1-2 accumulator piston, 2nd clutch fluid exhaust and the 2-4 band release.

1-2 Upshift Checkball (#8): Exhausting 2nd clutch fluid pressure unseats the ball and is routed through the 2nd fluid circuit.

Converter Clutch Signal Valve: 2nd fluid exhausts from the converter clutch signal valve. Refer to Park range on for a description of the TCC signal valve operation in First gear.

LO and REVERSE CLUTCH APPLIES

Lo Overrun Valve: Lo 1st fluid is regulated through the lo overrun valve and into the lo/reverse fluid circuit to control the lo/reverse clutch apply.

Lo/Reverse Piston: Lo/reverse fluid pressure acts on the inner area of the piston to move the piston and apply the lo/reverse clutch plates.

OVERRUN CLUTCH APPLIED

The overrun clutch remains applied in Manual First to provide engine compression braking.

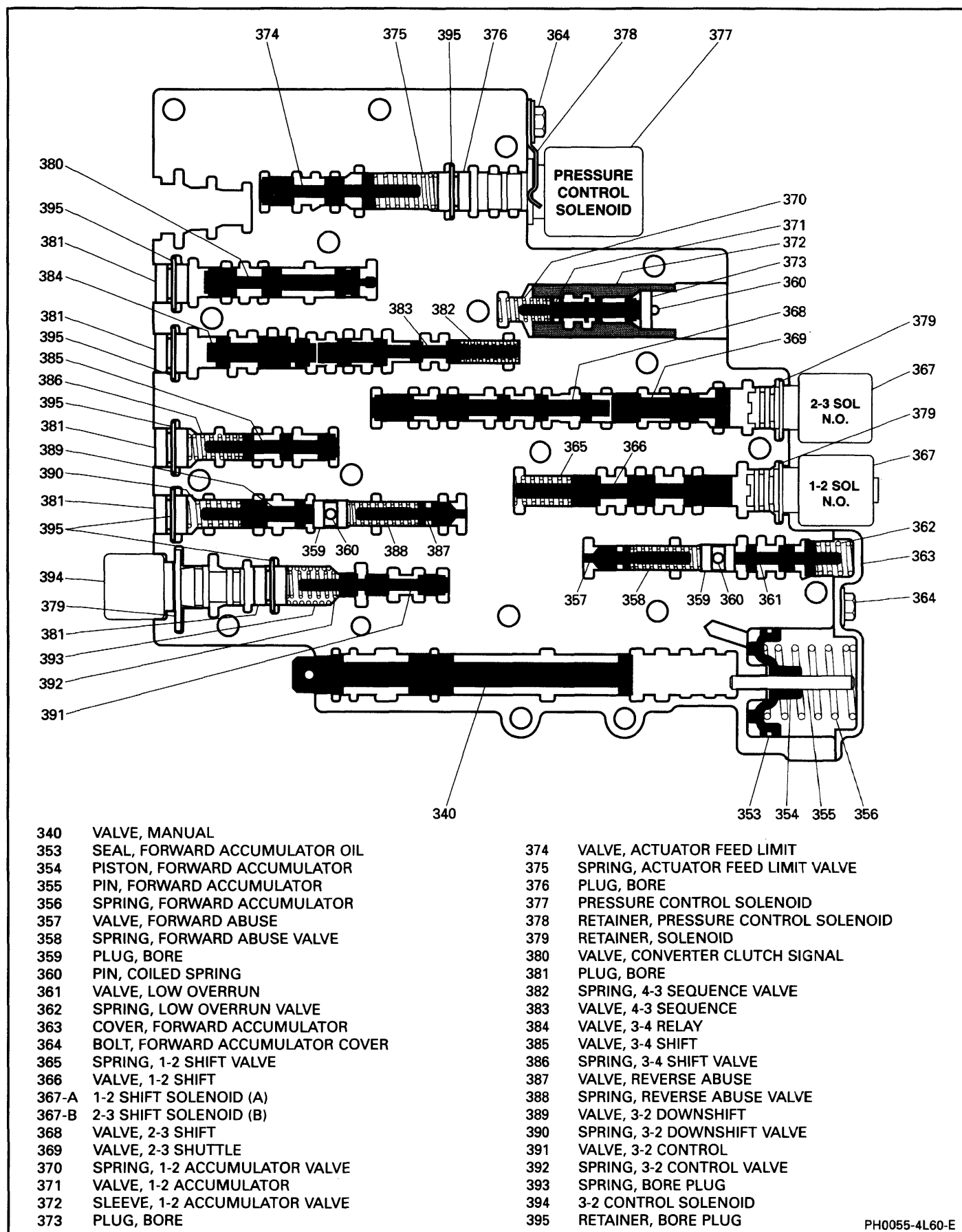
Pressure Control Solenoid: Similar to Manual Second, the PCM output signal to the force motor increases the operating range of torque signal fluid pressure. This provides increased line pressure for the additional torque requirements during engine compression braking and increased engine loads.

3-2 Downshift Control Solenoid and 3-2 Control Valve: In First gear the solenoid is OFF, AFL fluid is blocked by the solenoid, 3-2 signal fluid exhausts through the solenoid and spring force opens the 3-2 control valve.

SUMMARY

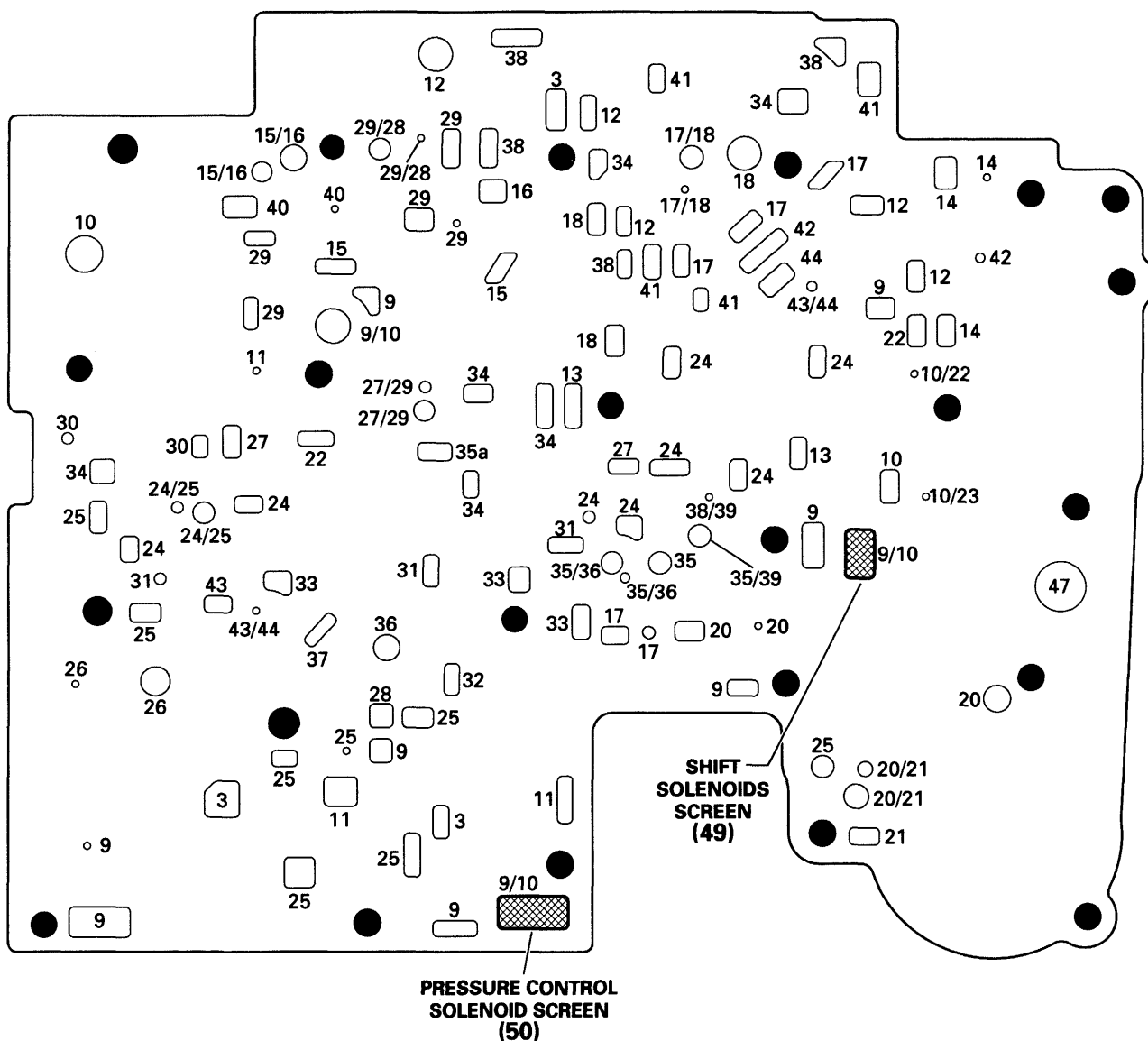
SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3			APPLIED	APPLIED	HOLDING		HOLDING	APPLIED
ON	ON								





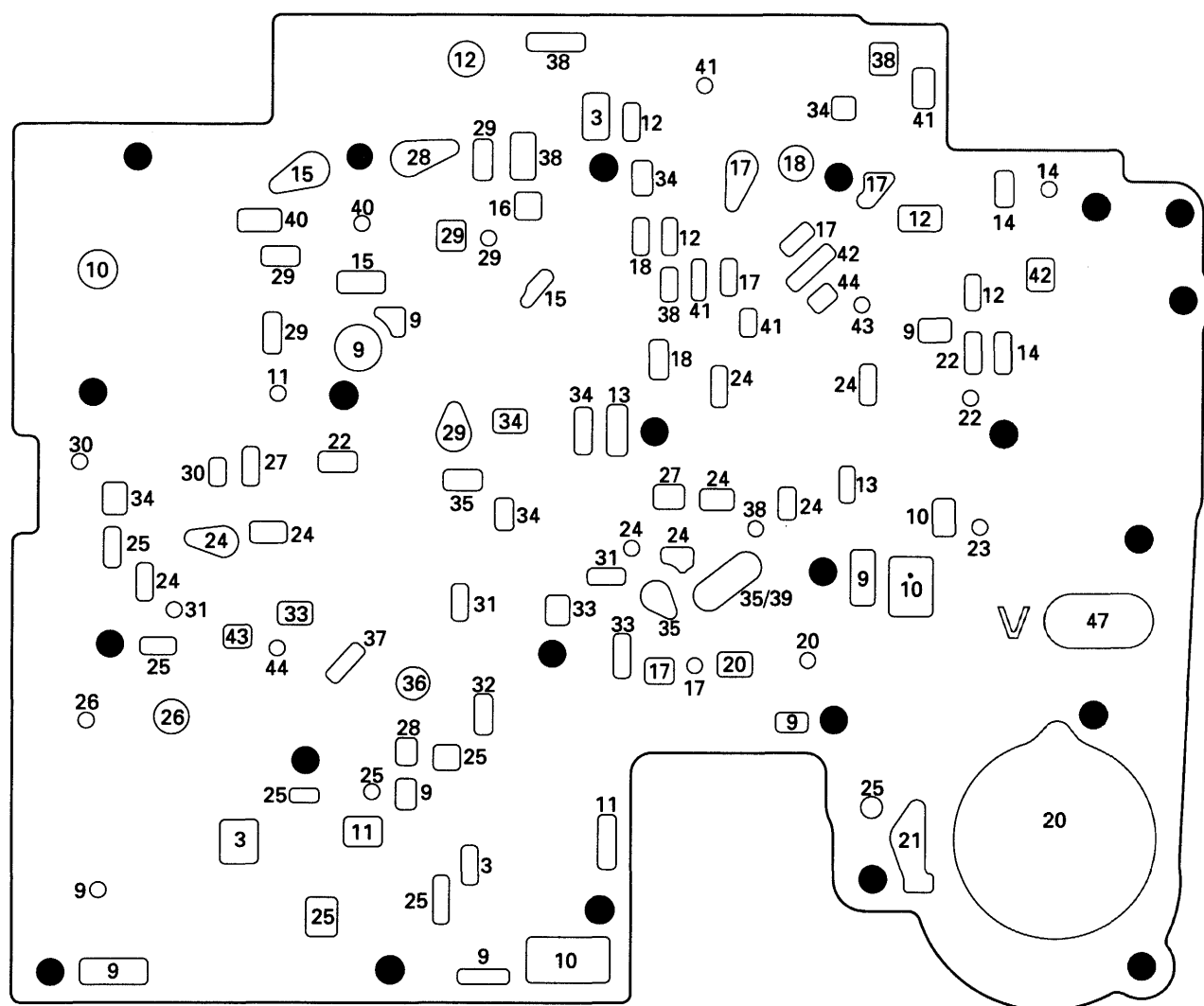
PH0055-4L60-E

Figure 69 Valve Trains

**PASSAGES**

- | | | |
|-----------------------------|--------------------------|------------------------|
| 1 SUCTION (INTAKE) | 18 FORWARD CLUTCH FEED | 35 OVERRUN |
| 2 DECREASE | 19 REAR LUBE | 36 OVERRUN CLUTCH FEED |
| 3 LINE | 20 ACCUMULATOR | 37 OVERRUN CLUTCH |
| 4 CONVERTER FEED | 21 ORIFICIED ACCUMULATOR | 38 D2 |
| 5 RELEASE | 22 SIGNAL A | 39 ORIFICIED D2 |
| 6 APPLY (REG APPLY) | 23 SIGNAL B | 40 3-2 SIGNAL |
| 7 TO COOLER | 24 2ND | 41 LO |
| 8 LUBE FROM COOLER | 25 2ND CLUTCH | 42 LO/1ST |
| 9 ACTUATOR FEED LIMIT | 26 C.C. SIGNAL | 43 EXHAUST |
| 10 FILTERED ACTUATOR FEED | 27 3-4 SIGNAL | 44 ORIFICIED EXHAUST |
| 11 TORQUE SIGNAL | 28 3RD ACCUM | 45 VENT |
| 12 PR | 29 3-4 CLUTCH | 46 SEAL DRAIN |
| 13 D4-3-2 | 30 4TH SIGNAL | 47 VOID |
| 14 LO/REVERSE | 31 SERVO FEED | |
| 15 REVERSE | 32 4TH | |
| 16 REVERSE INPUT (REV. CL.) | 33 3-4 ACCUM | |
| 17 D4 | 34 D3 | |

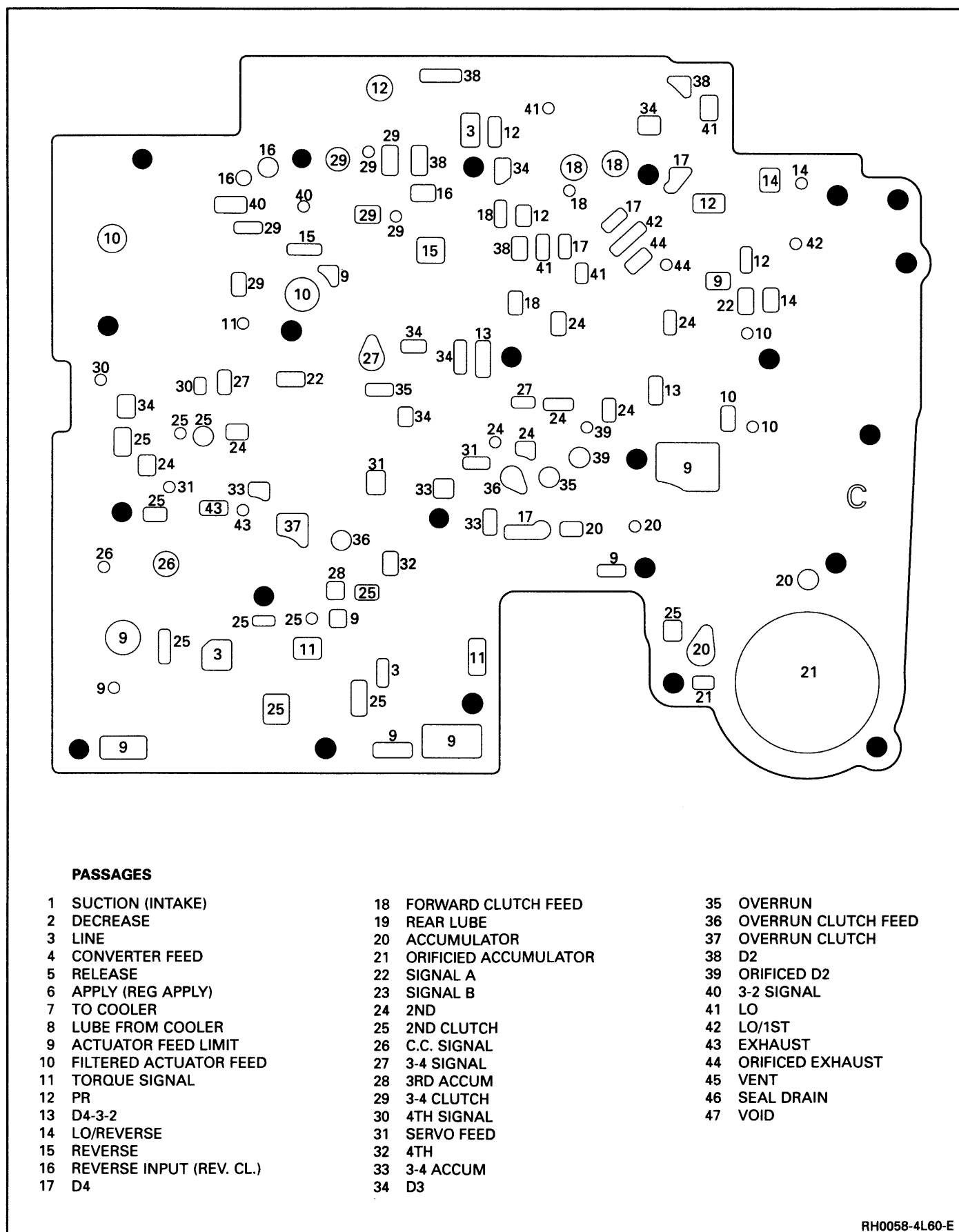
Figure 70 Spacer Plate Passages

**PASSAGES**

- | | | |
|-----------------------------|-------------------------|------------------------|
| 1 SUCTION (INTAKE) | 18 FORWARD CLUTCH FEED | 35 OVERRUN |
| 2 DECREASE | 19 REAR LUBE | 36 OVERRUN CLUTCH FEED |
| 3 LINE | 20 ACCUMULATOR | 37 OVERRUN CLUTCH |
| 4 CONVERTER FEED | 21 ORIFICED ACCUMULATOR | 38 D2 |
| 5 RELEASE | 22 SIGNAL A | 39 ORIFICED D2 |
| 6 APPLY (REG APPLY) | 23 SIGNAL B | 40 3-2 SIGNAL |
| 7 TO COOLER | 24 2ND | 41 LO |
| 8 LUBE FROM COOLER | 25 2ND CLUTCH | 42 LO/1ST |
| 9 ACTUATOR FEED LIMIT | 26 C.C. SIGNAL | 43 EXHAUST |
| 10 FILTERED ACTUATOR FEED | 27 3-4 SIGNAL | 44 ORIFICED EXHAUST |
| 11 TORQUE SIGNAL | 28 3RD ACCUM | 45 VENT |
| 12 PR | 29 3-4 CLUTCH | 46 SEAL DRAIN |
| 13 D4-3-2 | 30 4TH SIGNAL | 47 VOID |
| 14 LO/REVERSE | 31 SERVO FEED | |
| 15 REVERSE | 32 4TH | |
| 16 REVERSE INPUT (REV. CL.) | 33 3-4 ACCUM | |
| 17 D4 | 34 D3 | |

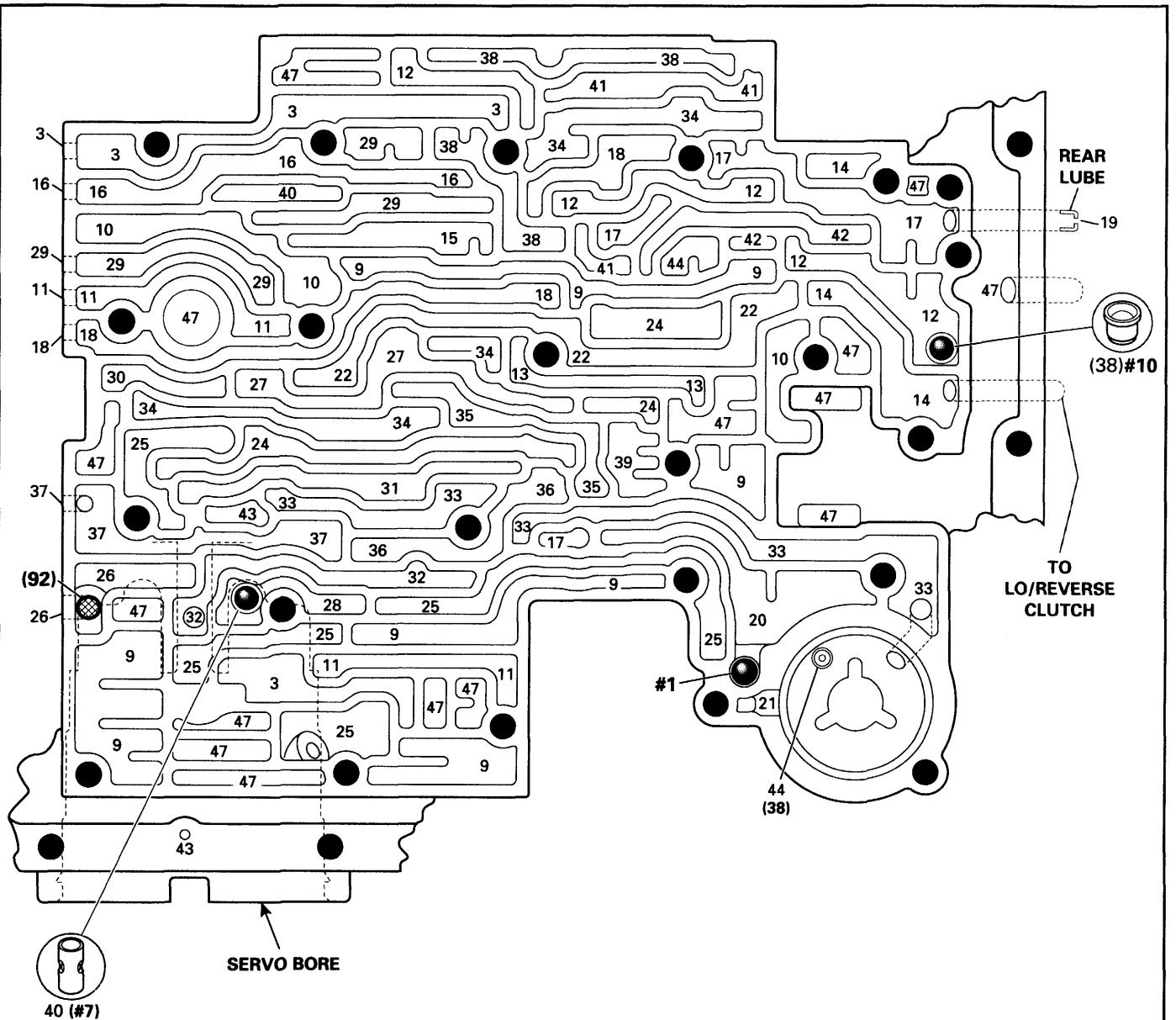
RH0057-4L60-E

Figure 71 Spacer Plate to Valve Body Gasket



RH0058-4L60-E

Figure 72 Spacer Plate to Case Gasket

**PASSAGES**

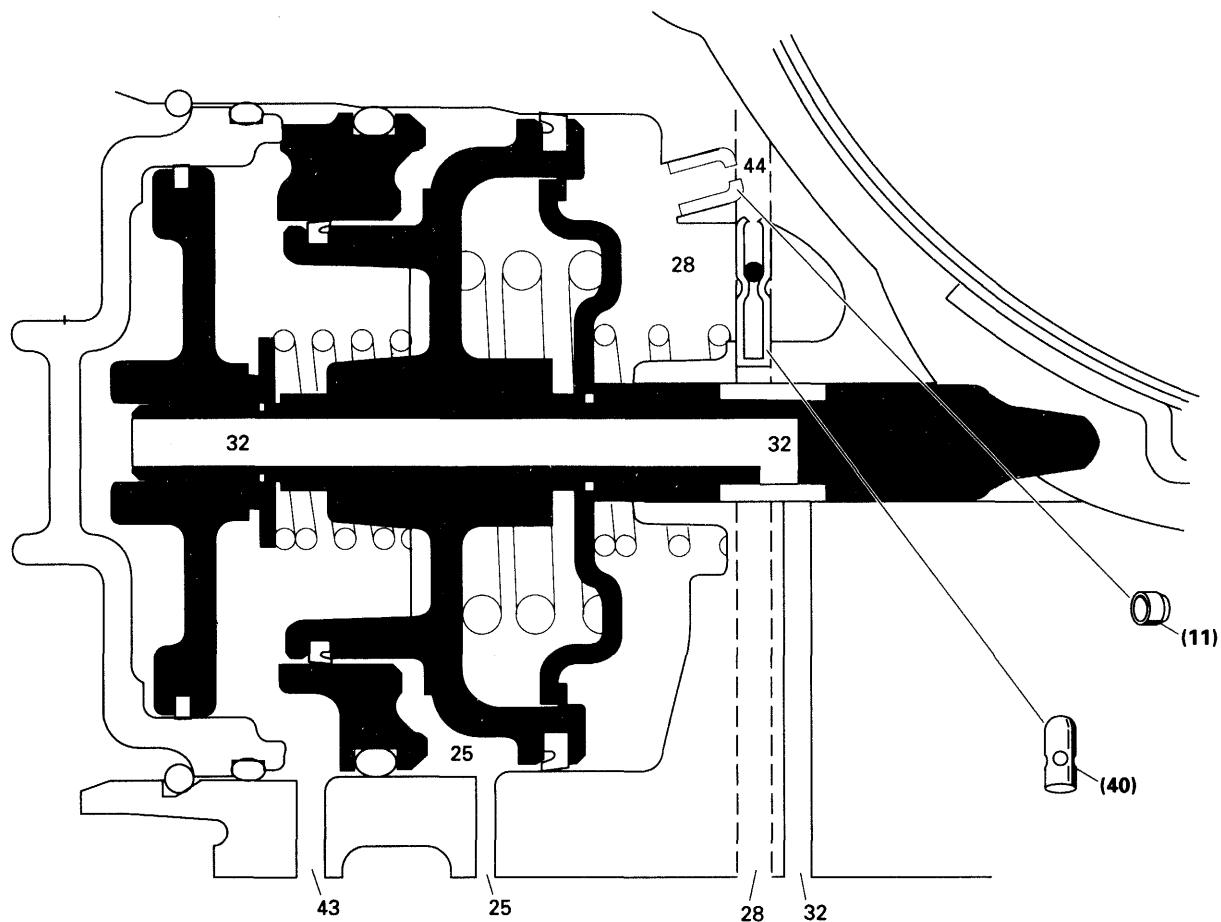
- | | | |
|-----------------------------|-------------------------|---------------------|
| 1 SUCTION (INTAKE) | 19 REAR LUBE | 37 OVERRUN CLUTCH |
| 2 DECREASE | 20 ACCUMULATOR | 38 D2 |
| 3 LINE | 21 ORIFICED ACCUMULATOR | 39 ORIFICED D2 |
| 4 CONVERTER FEED | 22 SIGNAL A | 40 3-2 SIGNAL |
| 5 RELEASE | 23 SIGNAL B | 41 LO |
| 6 APPLY (REG APPLY) | 24 2ND | 42 LO/1ST |
| 7 TO COOLER | 25 2ND CLUTCH | 43 EXHAUST |
| 8 LUBE FROM COOLER | 26 C.C. SIGNAL | 44 ORIFICED EXHAUST |
| 9 ACTUATOR FEED LIMIT | 27 3-4 SIGNAL | 45 VENT |
| 10 FILTERED ACTUATOR FEED | 28 3RD ACCUM | 46 SEAL DRAIN |
| 11 TORQUE SIGNAL | 29 3-4 CLUTCH | 47 VOID |
| 12 PR | 30 4TH SIGNAL | |
| 13 D4-3-2 | 31 SERVO FEED | |
| 14 LO/REVERSE | 32 4TH | |
| 15 REVERSE | 33 3-4 ACCUM | |
| 16 REVERSE INPUT (REV. CL.) | 34 D3 | |
| 17 D4 | 35 OVERRUN | |
| 18 FORWARD CLUTCH FEED | 36 OVERRUN CLUTCH FEED | |

COMPONENTS ()

- (38) ACCUMULATOR BLEED PLUG
 (40) 3RD ACCUM. RETAINER AND
 (92) TCC SCREEN

RH0059-4L60-E

Figure 73 Case Passages and Checkball Locations

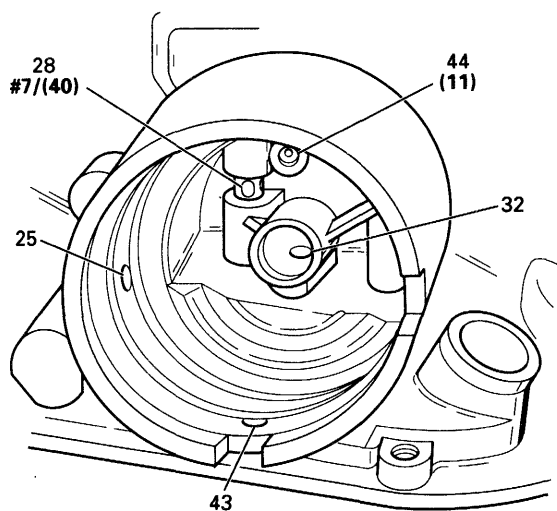


PASSAGES

- 25 2ND CLUTCH
- 28 3RD ACCUMULATOR
- 32 4TH
- 43 EXHAUST
- 44 ORIFICED EXHAUST

COMPONENTS ()

- (11) CASE SERVO ORIFICED PLUG
- (40) 3RD ACCUM. RETAINER AND BALL ASSEMBLY (#7)



RH0062-4L60-E

Figure 74 2-4 Servo Passages

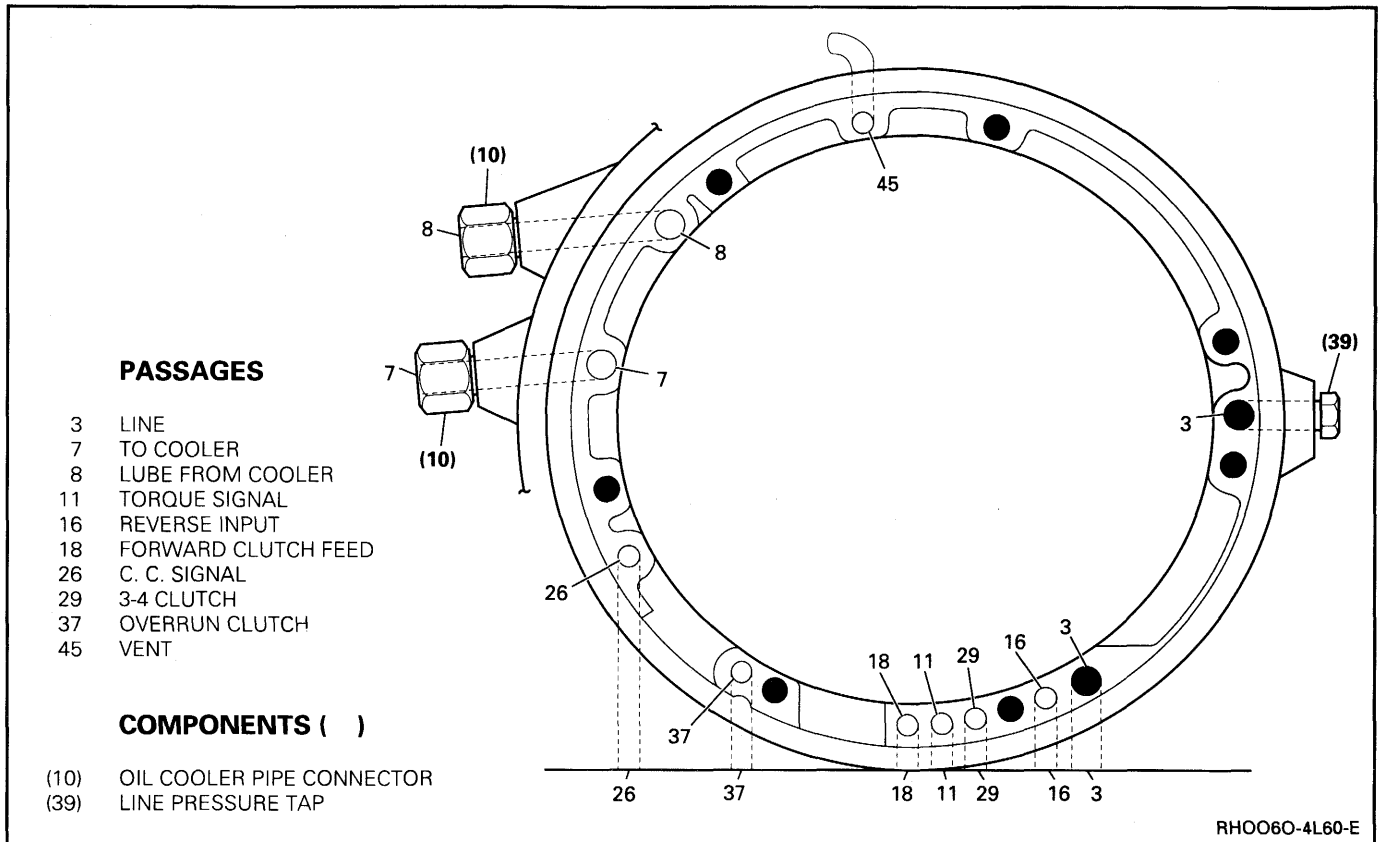


Figure 75 Pump to Case Passages

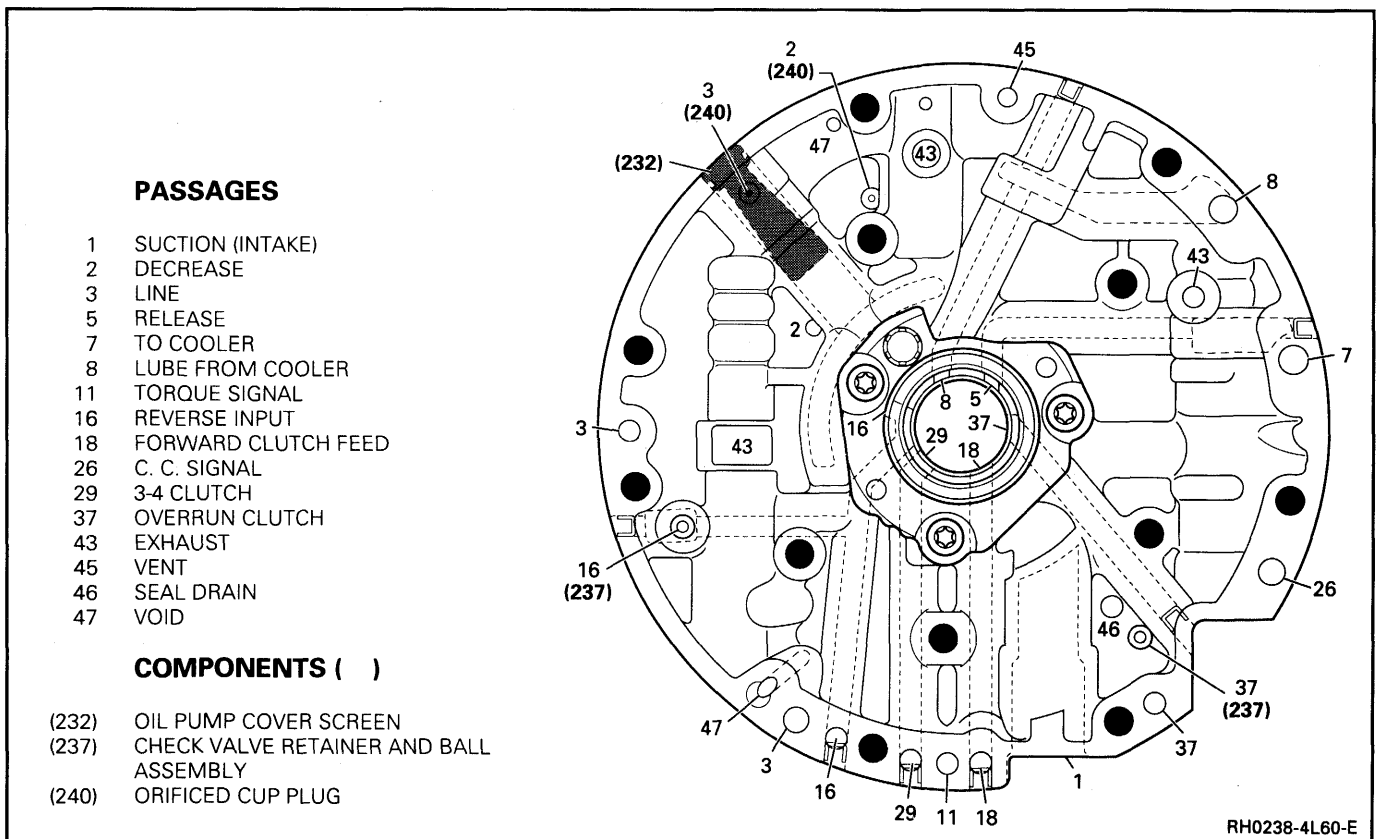


Figure 76 Pump Cover Passages (Case Side)

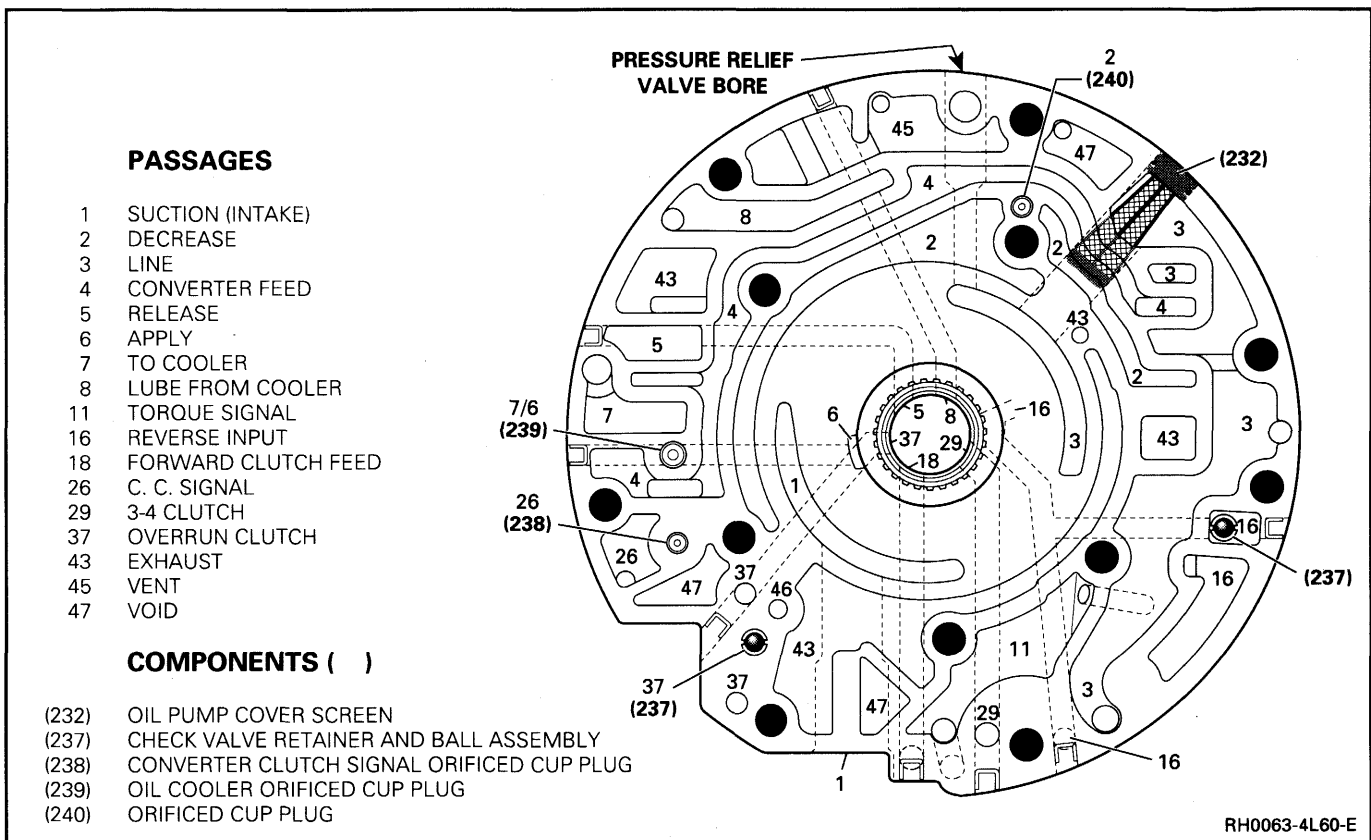


Figure 77 Pump Cover Passages

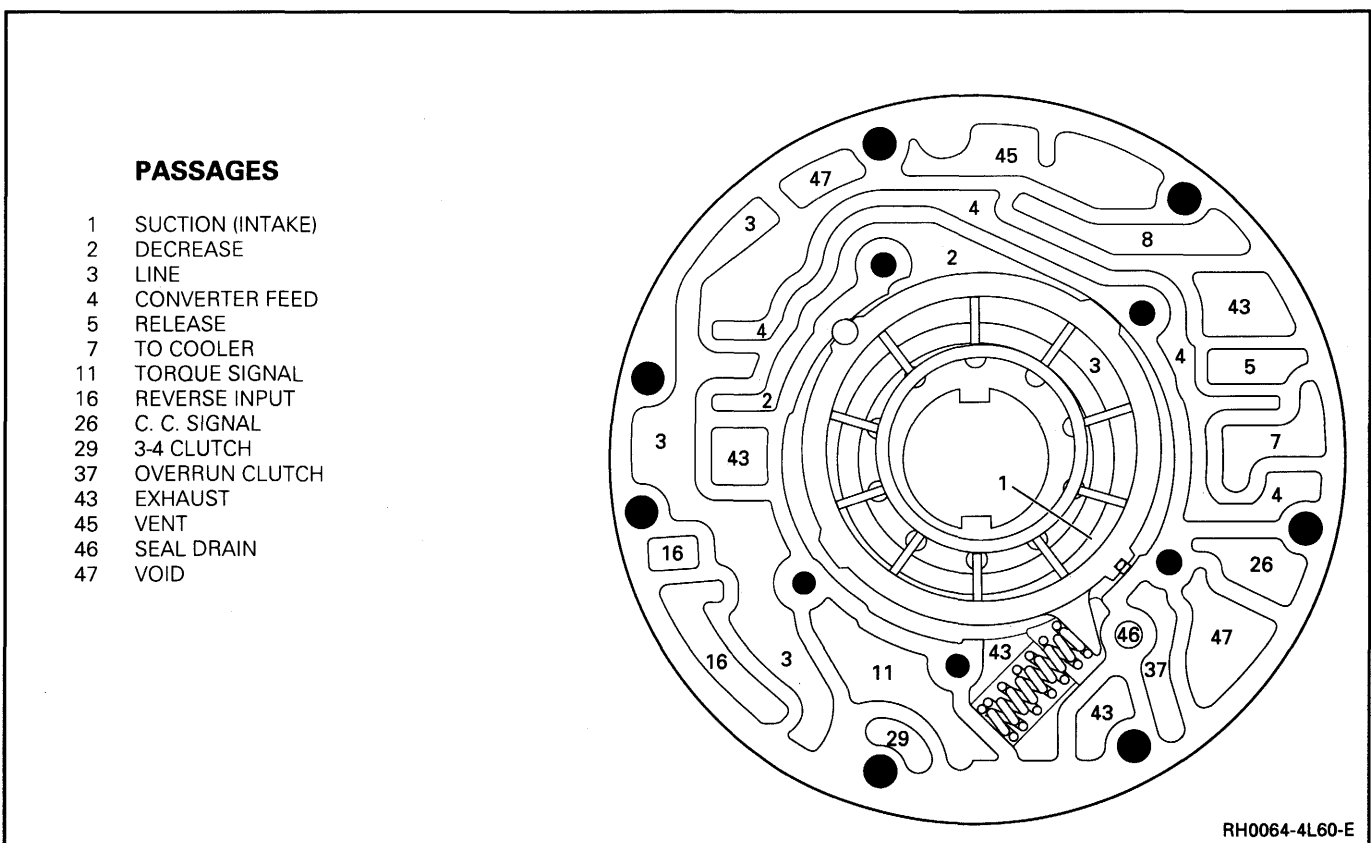
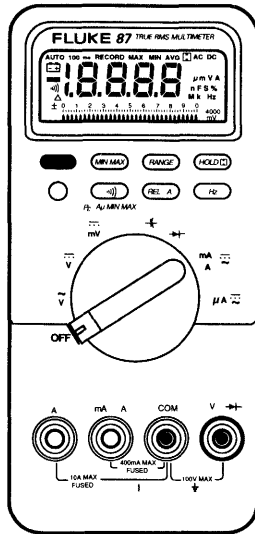


Figure 78 Pump Body Passages



FLUKE 87 TRUE RMS
MULTIMETER
J 39200

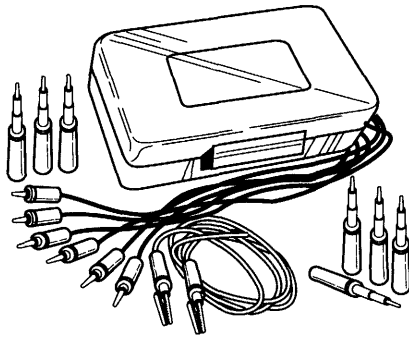
VOLTMETER – Voltage position measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 meg ohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings because they have a very high resistance.

AMMETER – When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information.

- Selector must be set properly for both function and range. DC is used for most automotive measurements.

OHMMETER – Measures resistance of circuit directly in ohms. Refer to meter instructions for more information.

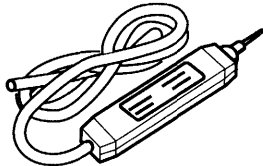
- OL display in all ranges indicates open circuit.
- Zero display in all ranges indicates a short circuit.
- An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit.
- Autoranges to the 400 Ω, 4 kΩ, 40 kΩ, 400 kΩ, 4 MΩ, or 40 MΩ resistance range.



J 35616-A

CONNECTOR TEST ADAPTER KIT

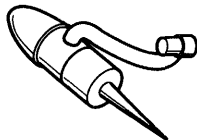
Assortment of flexible connectors to adapt a multimeter or jumper cords to connect



J 34636

CIRCUIT TESTER

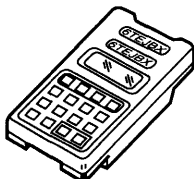
Used for checking all relays and solenoids before connecting them to a new ECM. Measures the circuit resistance and indicates pass or fail via green or red LED. Amber LED indicates current polarity. Can also be used as a non-powered continuity checker.



J 34142-A

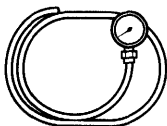
UNPOWERED TEST LIGHT

Used for checking wiring for complete circuit, short to ground, or voltage.



TECH 1 TESTER

Used to check solenoids and other electronic components. Can record vehicle data during dynamic testing, and turn some electronic components on and off.



J 21867

UNIVERSAL PRESSURE GAUGE SET

(9 Ft. Hose; 0-300 PSI)

Used for checking line pressure, pump output (min., max.) in all gear ranges.

RH0239-4L60-E

Figure 79 Electrical Diagnosis Tools

SECTION 7A14B

4L60-E AUTOMATIC TRANSMISSION ON-VEHICLE SERVICE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number for the application. If the correct part number is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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ON-VEHICLE SERVICE

PARTS CLEANING, INSPECTION, AND REPLACEMENT

- Use appropriate safety equipment such as:
 - Safety glasses.
 - Safety shoes.
 - Gloves.
- Keep the work area and tools clean.

- Clean the exterior of the transmission before removing any parts.
- Do not use wipe cloths or rags.
- Do not use solvents on rubber seals or plastic/Teflon® thrust washers.
- Blow out all passages with compressed air.
- Clean small passages with fine wire.
- Handle parts carefully to prevent damage.

- Lubricate all internal parts with transmission fluid during assembly.
- When installing screws, bolts, or studs into aluminum, always dip the threads in transmission fluid.
- Always use a torque wrench for the proper torque.
- Recondition damaged or stripped aluminum threads with thread inserts.
- Replace all gaskets and O-ring seals.
 - Do not use gasket cement or sealers.
- Replace plastic/Teflon® thrust washers and install using the proper seal protector.



Inspect

- Manual linkage for wear at the pivoting points and bent or broken links and rods.
- All seals, gaskets, O-rings, and mating surfaces for nicks, cuts, or other damage.
- Snap rings for expansion or compression, distortion, nicks, and proper ring to groove fit.
- Bearings and thrust surfaces for wear, scoring, and pitting.

FLYWHEEL AND TORQUE CONVERTER VIBRATION TEST

1. Start the engine.
2. With the engine at idle speed and the transmission in "Park" or "Neutral," observe vibration.
3. Shut the engine off.

NOTICE: Some engine/transmission combinations cannot be balanced in this manner due to limited clearances between the torque converter bolts and engine. Make sure bolts do not bottom out in lug nuts or the torque converter cover could be dented and cause internal damage.



Remove or Disconnect

1. Converter cover attaching bolts.
2. Flywheel to torque converter attaching bolts.
3. Rotate the torque converter 1/3 turn.



Install or Connect

NOTICE: For steps 1 and 2, refer to "Notice" on page 7A14B-1.

1. Flywheel to torque converter attaching bolts.



Tighten

- Bolts to 44 N.m (33 lbs. ft.).

2. Converter cover bolts.



Tighten

- Bolts to 11 N.m (97 lbs. in.).

3. Start the engine and check for vibration. Repeat the procedure until the best possible balance is obtained.

FLUID LEAK DIAGNOSIS AND REPAIR

The cause of most external leaks can generally be located and repaired with the transmission in the vehicle.

METHODS FOR LOCATING LEAKS

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut the engine off and look for fluid spots on the paper.
6. Make the necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder (foot powder) to the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Shut the engine off.
5. Inspect the suspected leak area and trace the leak path through the powder to find the source.
6. Make the necessary repairs.

Dye and Black Light Method

1. Follow the manufacturer's recommendation for the amount of dye to be used.
2. Find the leak with a black light.
3. Make the necessary repairs.

REPAIRING THE LEAK

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, make sure the following conditions are correct as they may cause a leak.

Gaskets

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Improperly torqued fasteners or dirty/damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs, or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant used (where applicable).
- Porosity.

Seals

- Fluid level and/or pressure is too high.
- Plugged vent or drain-back holes.
- Damaged seal bore (scratched, burred, or nicked).
- Damaged or worn seal.

- Improper installation.
- Cracks in component.
- Manual or output shaft surface scratched, nicked, or missing.
- Loose or worn bearing causing excess seal wear.

POSSIBLE POINTS OF OIL LEAKS

1. Transmission and transmission oil pan:
 - Attaching bolts not torqued correctly.
 - Improperly installed or damaged gasket.
 - Oil pan or mounting face not flat.
2. Case leak:
 - Filler tube multi-lip seal damaged or missing.
 - Filler tube bracket misaligned.
 - Vehicle speed sensor seal damaged.
 - Manual shaft seal damaged.
 - Oil cooler connector fittings loose or damaged.
 - Propeller shaft oil seal worn or damaged.
 - Line pressure pipe plug loose.
 - Porous casting.
3. Leak at converter end:
 - Converter seal damaged.
 - Seal lip cut (check converter hub for damage).
 - Bushing moved forward and damaged.
 - Garter spring missing from seal.
 - Converter leak in weld area.
 - Porous casting (case or pump).
4. Fluid comes out vent pipe or fill tube:
 - Overfilled.
 - Water or coolant in fluid (fluid will appear milky).
 - Case porous.
 - Incorrect fluid level indicator.
 - Plugged vent.
 - Drain back holes plugged.
 - The alignment of the oil pump to case gasket (if equipped).

CASE POROSITY REPAIR

1. Clean the leak area with solvent and air dry.

CAUTION: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Mix a sufficient amount of epoxy adhesive (GM P/N 1052533) or equivalent following the manufacturer's recommendations.
3. While the transmission case is hot, apply epoxy adhesive with a clean, dry soldering acid brush.
4. Allow the epoxy adhesive to cure for 3 hours before starting the engine.
5. Repeat fluid leak diagnosis procedures.

TORQUE CONVERTER CLUTCH ELECTRICAL CONTROLS

The torque converter clutch (TCC) system uses controls that are internal as well as external to the transmission. For internal control components of the TCC system, refer to SECTION 7A14A for the Hydraulic

Diagnosis Charts, wiring diagrams, and switch locations.

The external control components of the TCC system include:

- Brake Release Switch—To avoid stalling the engine when braking, the converter clutch is released any time the brakes are applied.
- Engine Control Module—Receives input signals and grounds TCC solenoid to apply the clutch when the proper operating conditions are met.
- Throttle Position Sensor—Sends throttle position information to the Powertrain Control Module.
- Vacuum Sensor—Sends engine vacuum (load) information to the Powertrain Control Module.
- Vehicle Speed Sensor—Sends vehicle speed information to the Powertrain Control Module.
- Engine Coolant Temperature Sensor—Sends engine coolant temperature information to the Powertrain Control Module.

TORQUE CONVERTER CLUTCH DIAGNOSIS

To properly diagnose the torque converter clutch system, perform all electrical testing before hydraulic testing. For additional testing of the torque converter clutch system, refer to "Torque Converter Clutch Electrical Controls."

SHIFT LINKAGE



Remove or Disconnect (Figure 1)

- Note the position of any washers, spacers, and insulators being removed.
 - Apply the parking brake.
1. Screw (226) and the washer.
 2. Rod (240) and the swivel (244) from the column lever.
 3. Retaining pin (232).
 4. Rod (240) from the equalizer lever (238).
 - Bearing and the insulator.
 5. Retaining pin (227).
 6. Equalizer lever (238).



Clean

- Metal parts using solvent. Wipe dry using a clean, dry rag.
- Rubber or nylon parts using soapy water. Wipe dry using a clean, dry rag.



Install or Connect (Figure 1)

1. Equalizer lever (238) and a new retaining pin (227).
2. Rod (240) to the equalizer lever (238).
 - Insulator and bearing.
3. New retaining pin (232).
4. Swivel (244) and the rod (240) to the column lever.
 - Adjust the linkage. Refer to "Shift Linkage Adjustment."

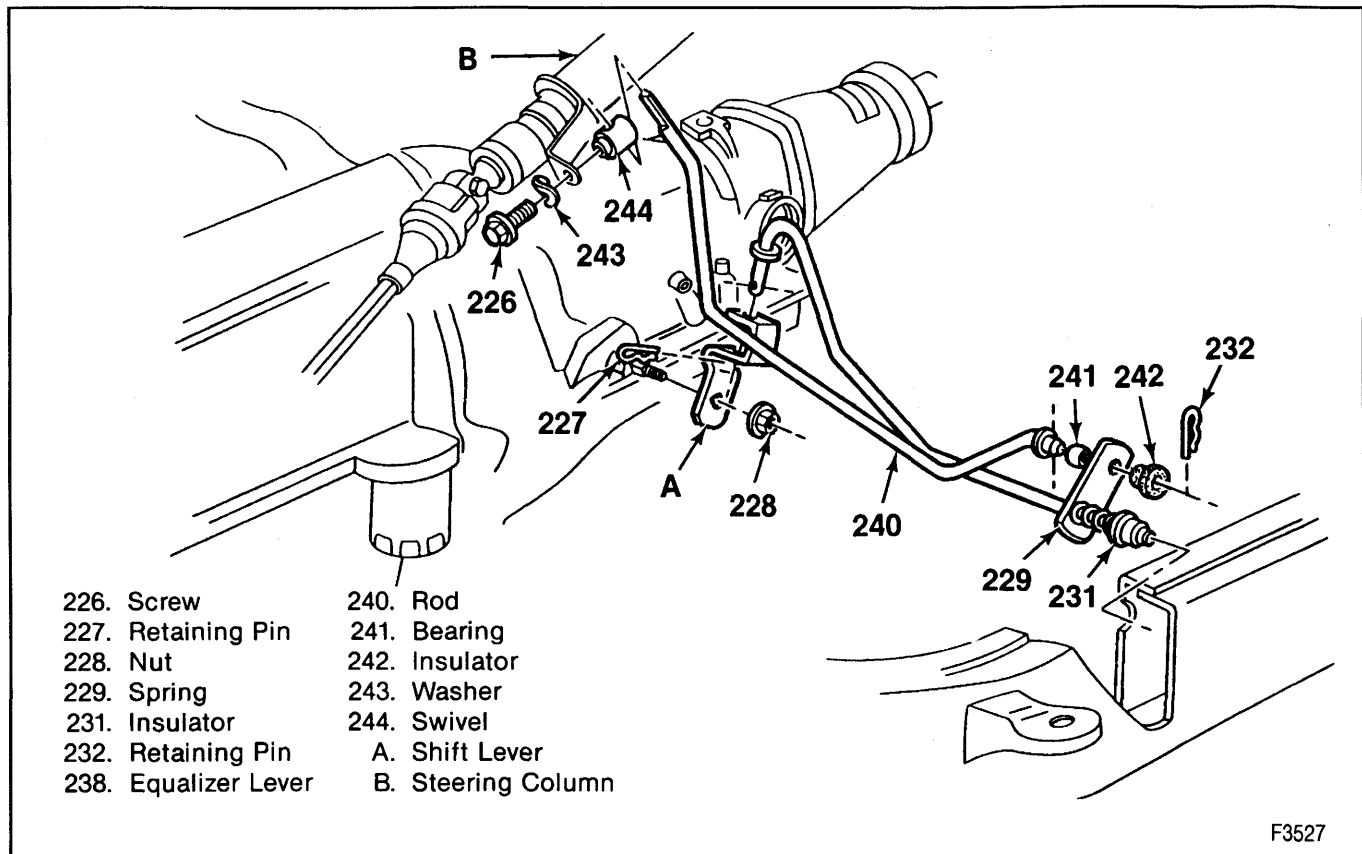


Figure 1—Shift Linkage

SHIFT LINKAGE ADJUSTMENT

Remove or Disconnect

- Apply the parking brake.
- 1. Loosen the screw (226).
- 2. Put the column selector lever in the "N" (Neutral) position.
 - Put the lever in the neutral gate, do not use the indicator to find the neutral position.

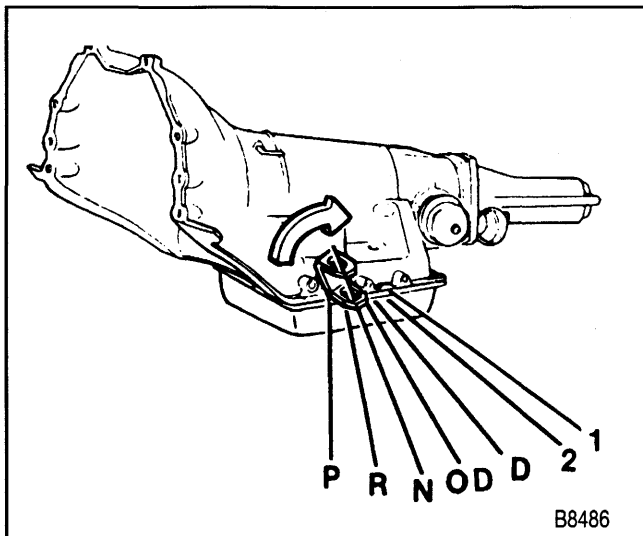


Figure 2—Shift Positions

- Put the transmission in neutral.

- Move the shift lever (A) to the forward position, then back to the second detent.

NOTICE: Refer to "Notice" on page 7A14B-1.

- Hold the rod (240) tightly in the swivel (244).

Tighten

- Nut (226) to 23 N.m (17 lbs. ft.).
- Put the column selector lever in the "P" (Park) position.
 - Check the adjustment.
 - The column selector lever must go into all positions.
 - The engine must start in the "P" (Park) or "N" (Neutral) positions only. Adjust if needed. Refer to "Shift Indicator Adjustment".

CAUTION: With the selector lever in the "Park" position, the parking pawl should freely engage within the rear (reaction) internal gear lugs or output ring gear lugs and prevent the vehicle from rolling, which could cause personal injury.

- Align the indicator, if needed.
- Release the parking brake.

CHANGING THE FLUID AND FILTER

Remove or Disconnect (Figure 3)

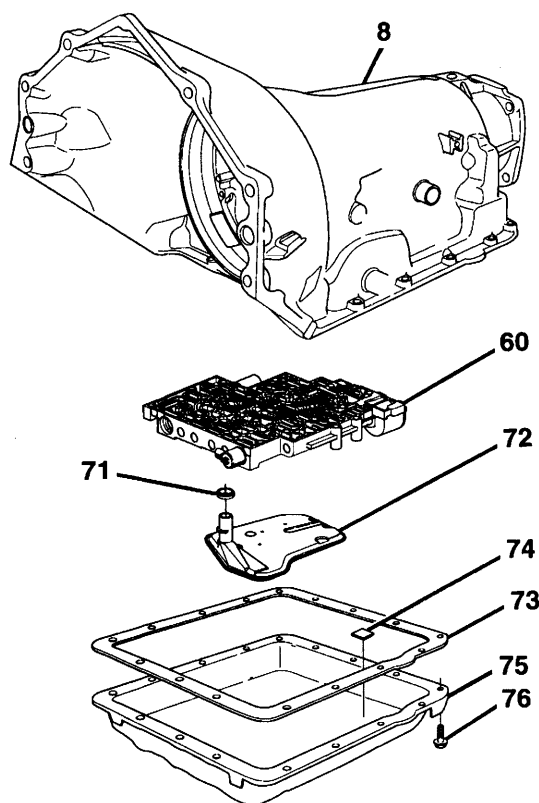
- Raise the vehicle and support it with safety stands.
- On some vehicles with certain equipment it may be necessary to move the crossmember at rear of the transmission. Use a stand to support the tailshaft if the crossmember is moved.
- Place a drain pan under the transmission oil pan.

1. Oil pan screws from the front and sides only.

- Loosen the rear oil pan screws approximately 4 turns.

Important

- Use care, if prying the oil pan down, not to damage the sealing surfaces of the oil pan or transmission case.



- 8. CASE, TRANSMISSION
- 60. VALVE ASSEMBLY, CONTROL BODY
- 71. SEAL, FILTER
- 72. FILTER ASSEMBLY, TRANSMISSION OIL
- 73. GASKET, TRANSMISSION OIL PAN
- 74. MAGNET, CHIP COLLECTOR
- 75. PAN, TRANSMISSION OIL
- 76. SCREW, TRANSMISSION OIL PAN

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Figure 3—Transmission Fluid and Filter Replacement

2. Lightly tap the oil pan with a rubber mallet or pry down to allow the fluid to drain.

- Inspect the fluid color. Refer to SECTION 7A14A.

3. Remaining oil pan screws, oil pan, and gasket.

4. Oil filter and seal.

- The seal may be stuck in the pump.

Inspect

- Filter. Open the filter by prying the metal crimping away from the top of the filter (black) and pull apart. The filter may contain evidence for root cause diagnosis.
 - Clutch material.
 - Bronze slivers indicating bushing wear.
 - Steel particles.

Clean

- Transmission case and oil pan gasket surfaces with solvent and air dry.
 - All traces of the old gasket material must be removed.

Install or Connect (Figure 3)

- Coat a new seal with a small amount of TRAN-SJEL® J 36850 or equivalent.

1. New seal onto a new filter.

2. New filter into the case.

3. Transmission oil pan and a new gasket.

NOTICE: Refer to "Notice" on page 7A14B-1.

4. Transmission oil pan screws.

Tighten

- Screws to 12 N·m (106 lbs. in.).

5. Lower the vehicle.

6. New transmission fluid.

- Install crossmember if it was moved or loosened.

- Fill the transmission to the proper level with Dexron® 3 or Dexron® IIE Transmission Fluid. Refer to SECTION 7A14A.

Important

- Do not overfill.
- Check the oil pan gasket for leaks.

2-4 SERVO

Remove or Disconnect (Figures 4 and 5)

Tool Required:

J 29714-A Servo Cover Compressor

J 22269-01 Piston Compressor

- Raise the vehicle and suitably support it.
- Lower the transmission if needed for clearance. Refer to "Transmission Replacement."
- Install J 29714-A Servo Cover Compressor.

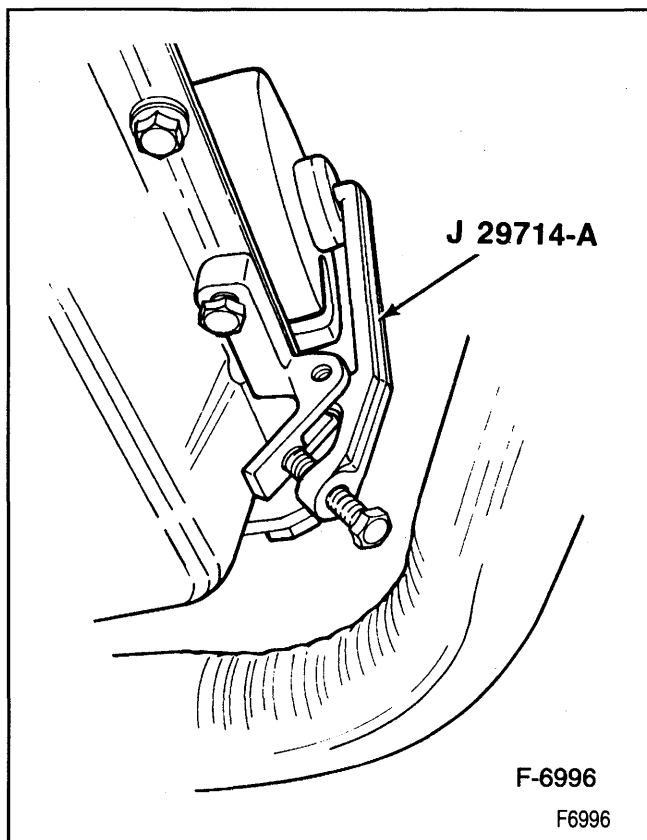


Figure 4—Removing The Servo Cover

1. Servo cover retaining ring (13).
2. Servo cover (15) and O-ring seal (14).
 - If the servo cover seems to be hung up on the seal, cut and remove the O-ring seal before removing the cover.
3. 4th apply piston (16).
4. Servo return spring (31).
5. Servo pin retainer ring (18), washer (19), and apply pin spring (20).
6. 2nd apply piston pin (29).
 - Install J 22269-01.
7. Cushion spring retainer (27) and cushion spring (26).



Disassemble (Figures 5, 6, and 7)

Tool Required:

J 22269-01 Piston Compressor.

1. Housing (22) from the piston (25).
 - Seal from the housing.
2. Retainer ring from the pin (29).
 - Washer and the spring.
3. Pin (29).
 - Seals from the pin.
4. Retainer ring from the piston (25) using J 22269-01.
5. Retainer and the spring.

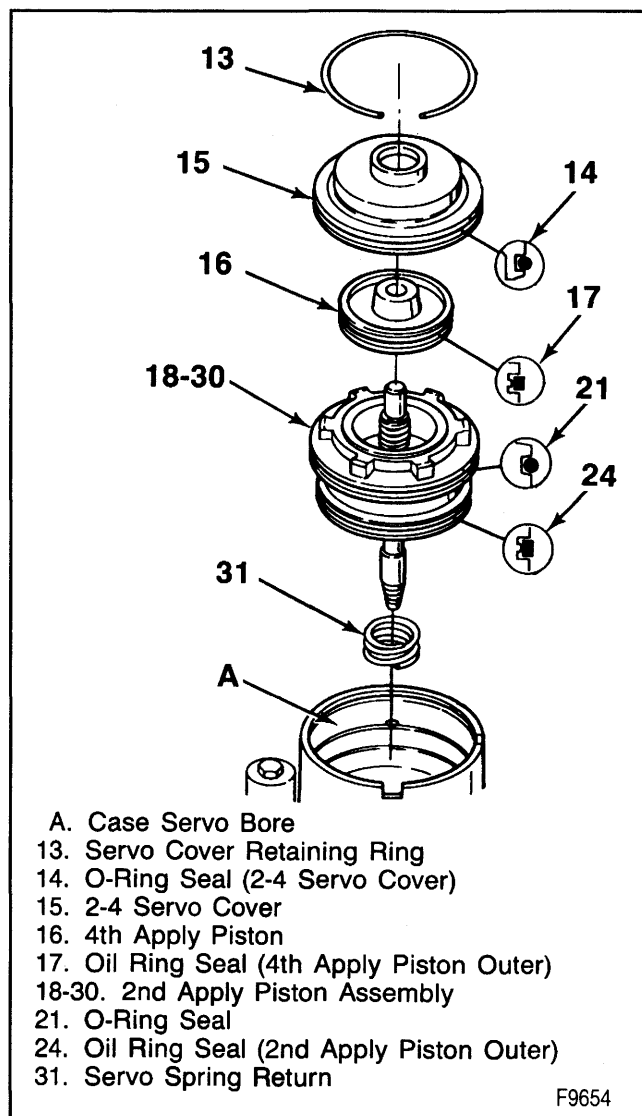


Figure 5—2-4 Servo

6. Seals from the piston.



Clean

- All parts using solvent. Air dry.



Inspect

- Pistons for porosity and damage.
- Seal grooves for damage.
- Cover for porosity and damage.
- Seals for nicks, cuts, and binding in the seal grooves.

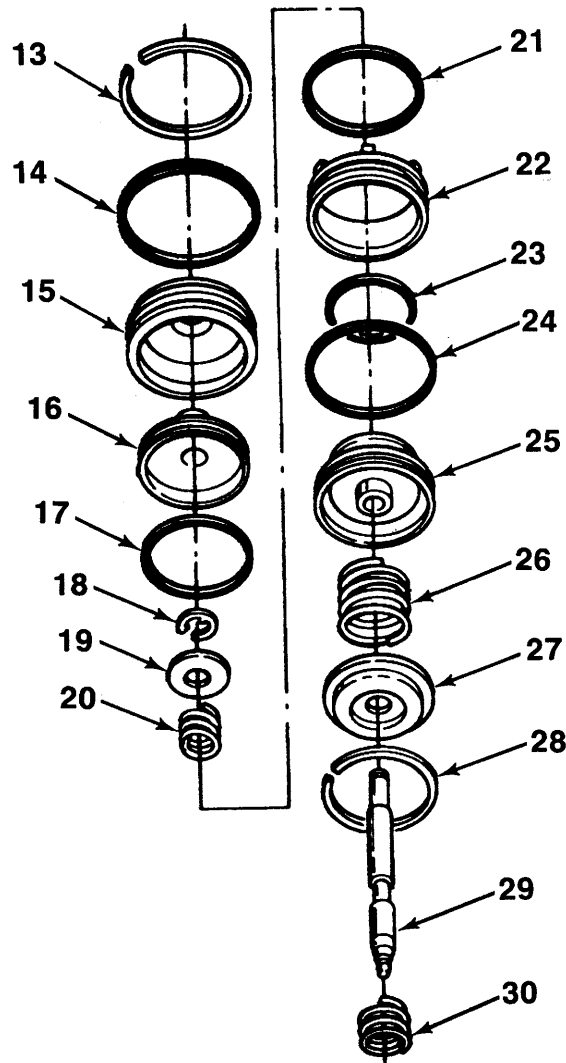
— If damage is found, check for the cause of the damage.

- Springs for kinks and bending.
- Pin for wear and burrs.



Important

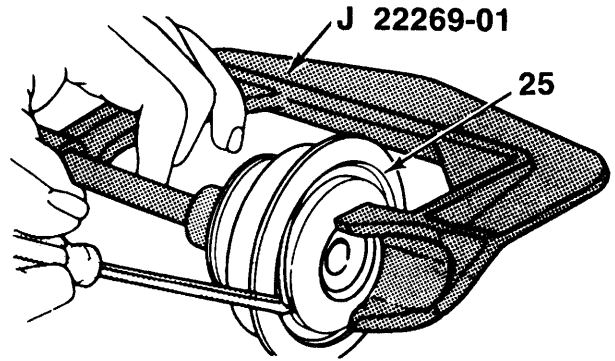
- Check the case servo bore for damage and sharp edges.



13. Servo Cover Retaining Ring
14. O-Ring Seal (2-4 Servo Cover)
15. 2-4 Servo Cover
16. 4th Apply Piston
17. Oil Ring Seal (4th Apply Piston Outer)
18. Retainer Ring (Apply Pin)
19. Servo Washer (Apply Pin)
20. Servo Spring (Apply Pin)
21. O-Ring Seal
22. Servo Piston Housing (Inner)
23. Oil Ring Seal (2nd Apply Piston Inner)
24. Oil Ring Seal (2nd Apply Piston Outer)
25. 2nd Apply Piston
26. Servo Spring Cushion
27. Servo Cushion Spring Retainer
28. Retainer Ring (2nd Apply Piston)
29. 2nd Apply Piston Pin
31. Servo Spring Return

F9655

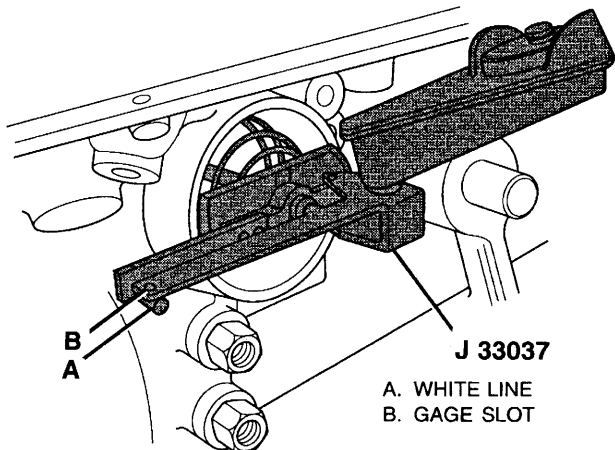
Figure 6—Apply Piston Assembly



25. Second Apply Piston Assembly

F9656

Figure 7—Removing the Retainer Pin



PIN IS PRESET AT FACTORY AND MUST NOT BE
READJUSTED

2-4 SERVO PIN SELECTION

PIN LENGTH		PIN I.D.
MM	INCH	
65.82-66.12	2.59-2.60	1 GROOVE
67.23-67.53	2.65-2.66	2 GROOVES
68.64-68.94	2.70-2.71	NO GROOVE

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Figure 8—Measuring the Servo Pin Length



Measure (Figures 8 and 9)

Tool Required:

J 33037 Band Apply Pin Tool Vernier Calipers
or Micrometer

1. Servo pin length (figure 8).

A. Install pin and J 33037 as shown.

B. Apply 11 N.m (97 lbs. in.) of torque and check
the gage slot (B).

— If the white line is seen in the slot, the pin is
correct.

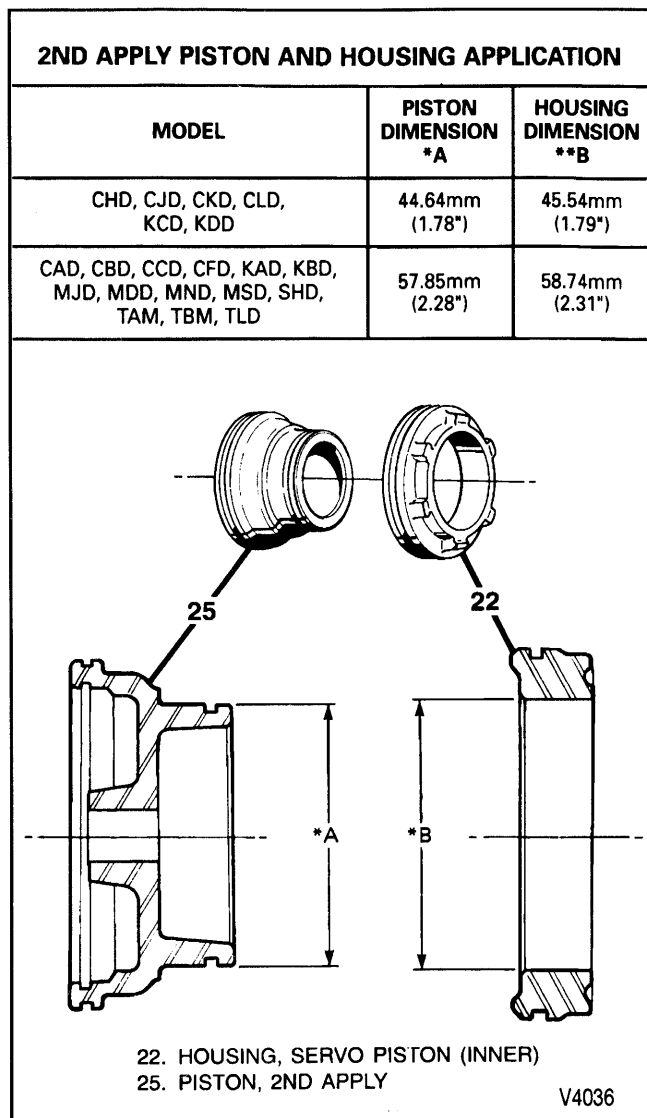


Figure 9—2nd Apply Piston and Housing Dimensions

— If the white line is not seen in the slot, replace the pin using the chart (figure 8).

C. Remove the pin and J 33037.

2. Piston and housing dimension (figure 9).

A. Measure the piston dimension (A).

B. Measure the housing dimension (B).

C. Check the chart for the proper dimensions.

Assemble (Figures 5, 6 and 7)

Tool Required:

J 22269-01 Piston Compressor

1. Retainer and spring in the piston (25).

A. New seals on the piston.

B. Retainer ring using J 22269-01.

2. Pin (29).

• New seals on the pin.

3. Retainer ring on the pin.

4. Spring and the washer.
5. Housing (22) on the piston (25).
6. New seal on the housing.

Important

- Make sure the seals are correctly positioned (figures 5 and 6).

Install or Connect (Figures 5 and 6)

Tool Required:

J 29714-A Servo Cover Compressor

1. Spring (31).
2. 2nd apply piston assembly (25).
3. 4th apply piston (16).
4. New seal on the cover.
5. Cover (15) and the retaining ring using J 29714-A.

- Raise the transmission if needed. Refer to "Transmission Replacement."
- Lower the vehicle.

6. Transmission fluid if needed. Refer to SECTION 7A14A.

FILLER TUBE REPLACEMENT

Remove or Disconnect (Figure 10)

1. Negative battery cable. Refer to SECTION 0A.
2. Transmission dipstick (101).
3. Air cleaner.
4. Bolt (102) from the tube bracket (103).

- Raise the vehicle.

5. Filler tube (104) from the transmission.

- Pull filler tube (104) up from the transmission.

6. Filler tube seal (105) from the filler tube (104).

Clean

- Metal parts using solvent. Do not allow solvent to enter the transmission. Air dry.

Install or Connect (Figure 10)

1. New filler tube seal (105) into the transmission case (106).
2. Filler tube (104) into the filler tube seal (105).

NOTICE: Refer to "Notice" on page 7A14B-1.

3. Tube bracket bolt (102).

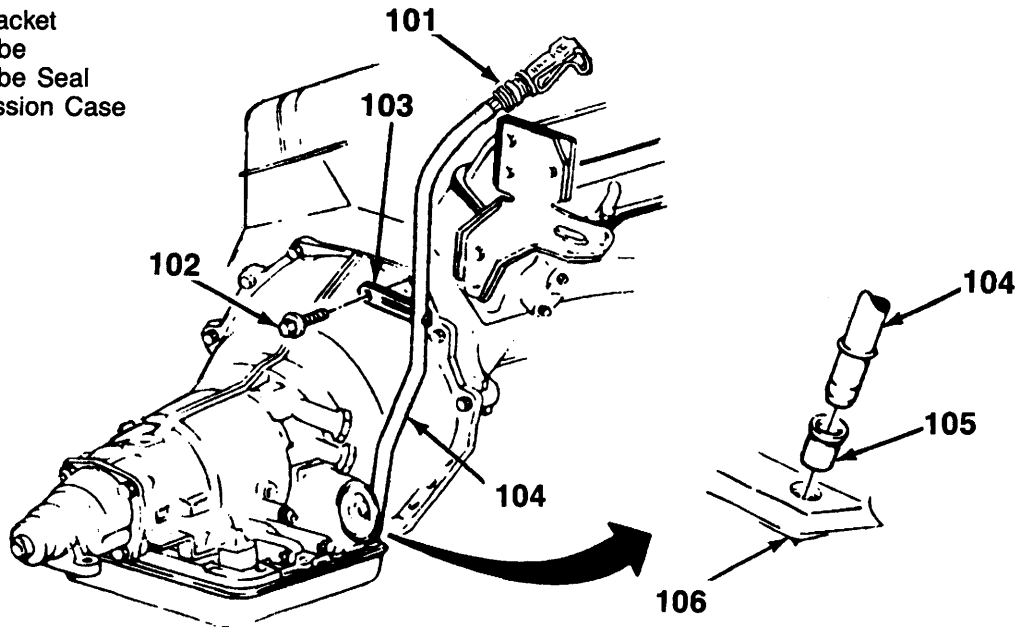
Tighten

- Bolt to 32 N.m (23 lbs. ft.).

- Lower the vehicle.

4. Air cleaner.
5. Transmission dipstick (101).
6. Negative battery cable.

- 101. Transmission Dipstick
- 102. Bolt
- 103. Tube Bracket
- 104. Filler Tube
- 105. Filler Tube Seal
- 106. Transmission Case



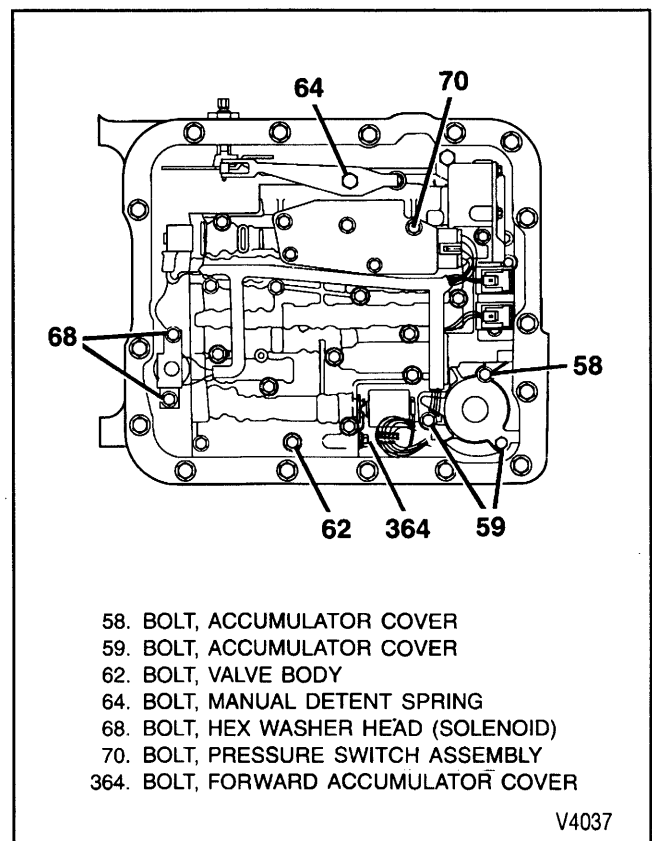
F6976

Figure 10—Filler Tube Replacement

VALVE BODY

↔ Remove or Disconnect (Figures 11 through 14)

1. Negative battery cable. Refer to SECTION 0A.
 - Raise vehicle and suitably support it.
 - Place drain pan under transmission oil pan.
2. Fluid. Refer to "Changing the Fluid and Filter."
3. Electrical connections from switches.
4. Solenoid bolts (68), TCC solenoid assembly with O-ring seal, and wiring harness (figure 11).
5. Accumulator cover bolts (58 and 59) and 1-2 accumulator cover and pin assembly (57) (figure 12).
6. Spring (54).
7. Bolt (64) and manual detent spring assembly (63) (figure 13).
8. Electrical wire clips.
9. Wiring harness retaining washer.
10. Remaining valve body bolts (62) (figure 11).
11. Manual valve link (89) (figure 14).
12. Control valve assembly (60) (figure 13).
13. Spacer plate (48) and spacer plate gaskets (47 and 52) (figure 12).
14. Checkballs, spring (46), piston (44), and pin (43).
 - Seven checkballs are located under the valve body, one is located in the case.



V4037

Figure 11—Control Valve Body Bolt Locations

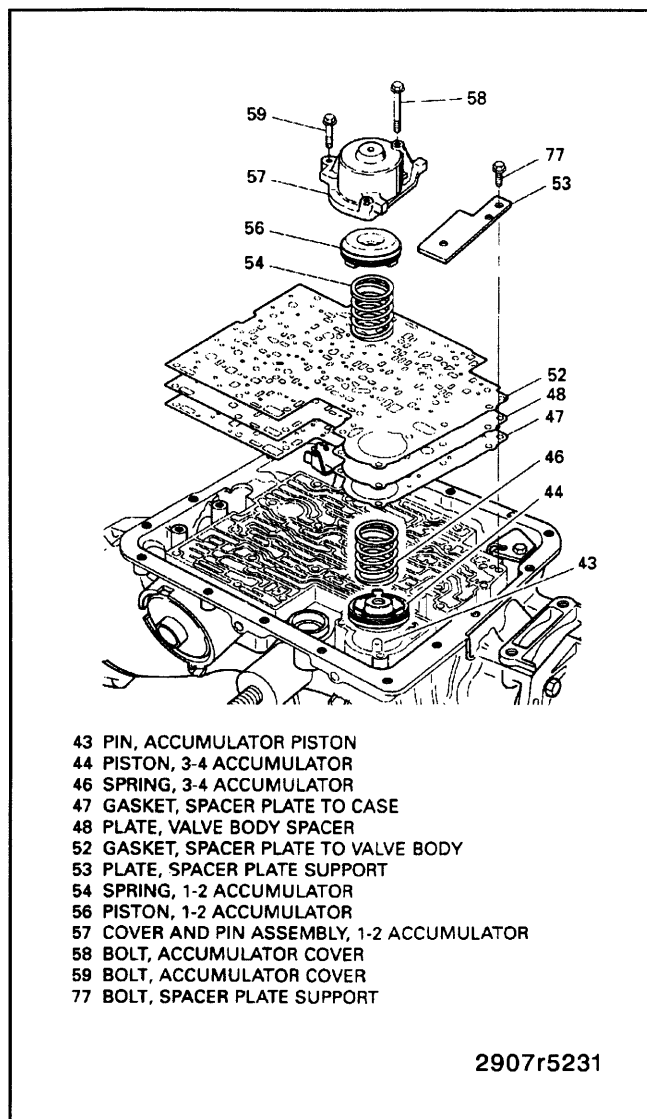


Figure 12—Accumulator Assembly, Spacer Plate, and Gaskets

Important

The use of a honing stone, fine sandpaper, or crocus cloth is not recommended for servicing stuck valves. All valve lands have sharply machined corners that are necessary to keep the bore clean. If these corners are rounded, foreign material could wedge between the valve and the bore causing the valve to stick. If it is found necessary to clean a valve, use micro fine lapping compound (900 grit or finer).

Too much lapping of the valve will cause excessive clearances and increase the chance of a valve not operating.

Clean (Figures 11 through 15)

- Valve body and associated parts thoroughly in clean solvent.
- Air dry.

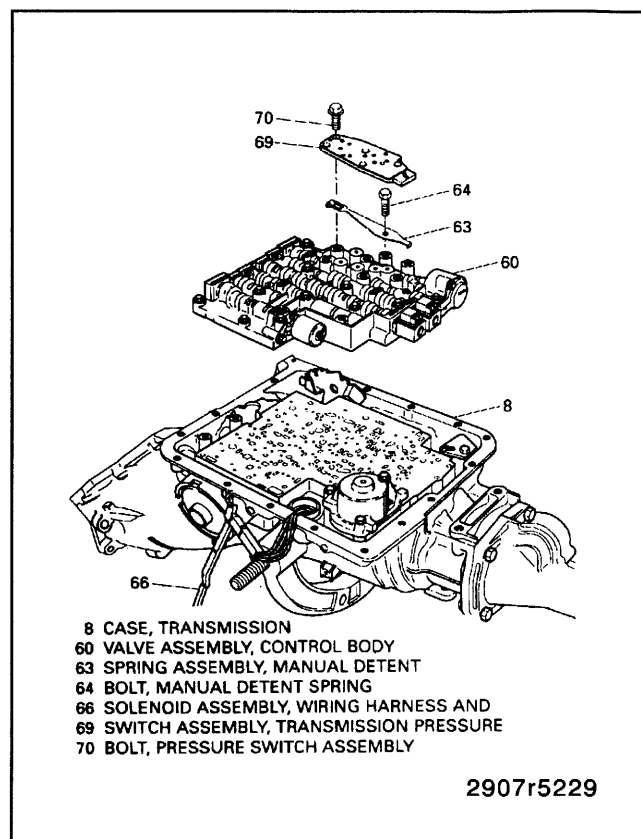


Figure 13—Control Valve and Pressure Switch Assembly

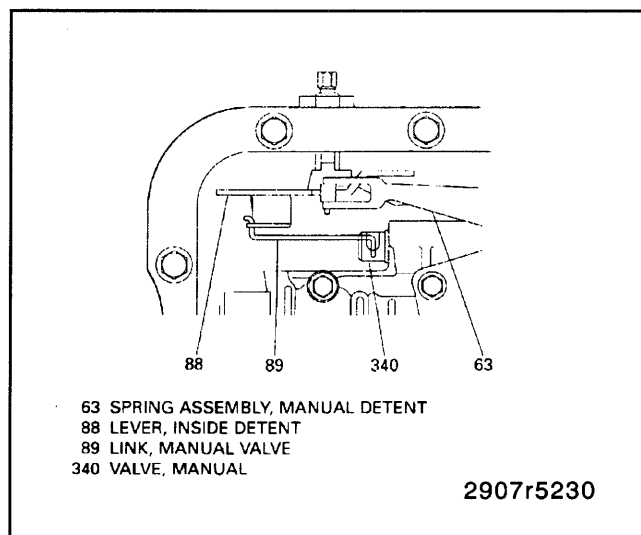


Figure 14—Manual Valve Link

Install or Connect (Figures 11 and 15)

Tool Required:
J 25025-5 Guide Pins

1. The wiring harness pass-through connector into the case.
2. The 3-4 accumulator pin (43) into the case (figure 12).
3. The 3-4 accumulator piston seal onto the 3-4 accumulator piston.

4. The 3-4 accumulator piston (44) onto the pin.
 - The end with three legs must face the valve body.
5. The 3-4 accumulator piston spring (46).
6. Torque converter clutch oil screen (92) (figure 15).
7. Checkball (91) into case as shown.
 - Retain with Transjell® J 36850 or equivalent.
8. J 25025-5 into the case.
9. Screens onto the spacer plate.
10. Spacer plate to case gasket (47) and spacer plate to valve body gasket (52) onto the spacer plate (48) (figure 12).
 - Gasket (47) identified by a "C."
 - Gasket (52) identified by a "V."
 - Retain with Transjell® J 36850 or equivalent.
11. Spacer plate and gaskets onto the case.

Important

- Be careful not to damage screens when installing the spacer plate and gaskets.

NOTICE: Refer to "Notice" on page 7A14B-1.

12. Spacer plate support (53) and bolts (77).

Tighten

- Bolts (77) to 11 N·m (97 lbs. in.).

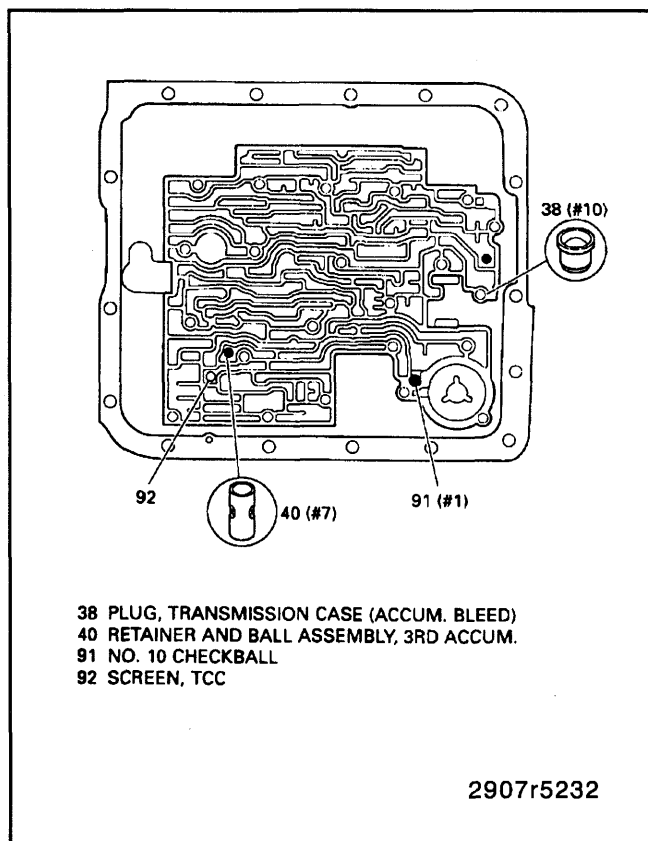


Figure 15—Case Checkballs and Filters

CONTROL VALVE BODY



Clean (Figures 16 and 17)

- Control valve assembly (350) thoroughly in clean solvent.
 - A. Move valves with a pick or small screwdriver to dislodge any dirt or debris that may have accumulated.
 - B. Air dry.

CAUTION: Some valves are under pressure. Cover the bores while removing the roll pins or personal injury could result.



Important

- Valves, springs, and bushings must be laid out on a clean surface in the exact sequence they were removed and as shown.



Disassemble (Figures 16 and 17)

1. Pressure control solenoid retainer bolt (364), retainer (378), and solenoid (377).
2. Bore plug retainer clip (395), bore plug (376), and valve train (374 and 375).
3. 2-3 shift solenoid retainer (379), solenoid (367), and valve train (368 and 369).
4. 1-2 shift solenoid retainer (379), solenoid (367), and valve train (365 and 366).
5. Accumulator valve train retainer pin (360), bore plug (373), and valve train (370 and 371).
6. Forward accumulator cover bolts (364) and cover (363).
7. Forward accumulator spring (356), piston (354), and pin (355).
8. Low overrun valve spring (362) and valve (361).
9. Retainer pin (360), bore plug (359), and forward abuse valve train (357 and 358).
10. Manual valve (340).
11. 3-2 control solenoid retainer clip (379) and solenoid (394).
12. Bore plug retainer (395), bore plug (381), and 3-2 control valve train (391 - 393).
13. 3-2 downshift bore plug retainer (395), bore plug (381), and valve train (389 - 390).
14. Reverse abuse bore plug retainer pin (360), bore plug (359), and valve train (387 - 388).
15. 3-4 shift valve bore plug retainer (395), bore plug (381), and valve train (385 - 386).
16. 3-4 shift valve bore plug retainer (395), bore plug (381), and valve train (382 - 384).
17. Torque converter clutch signal valve bore plug retainer (395), bore plug (381), and valve (380).



Clean

- All valves, springs, bushings, and control valve body in clean solvent.
- Dry using compressed air.

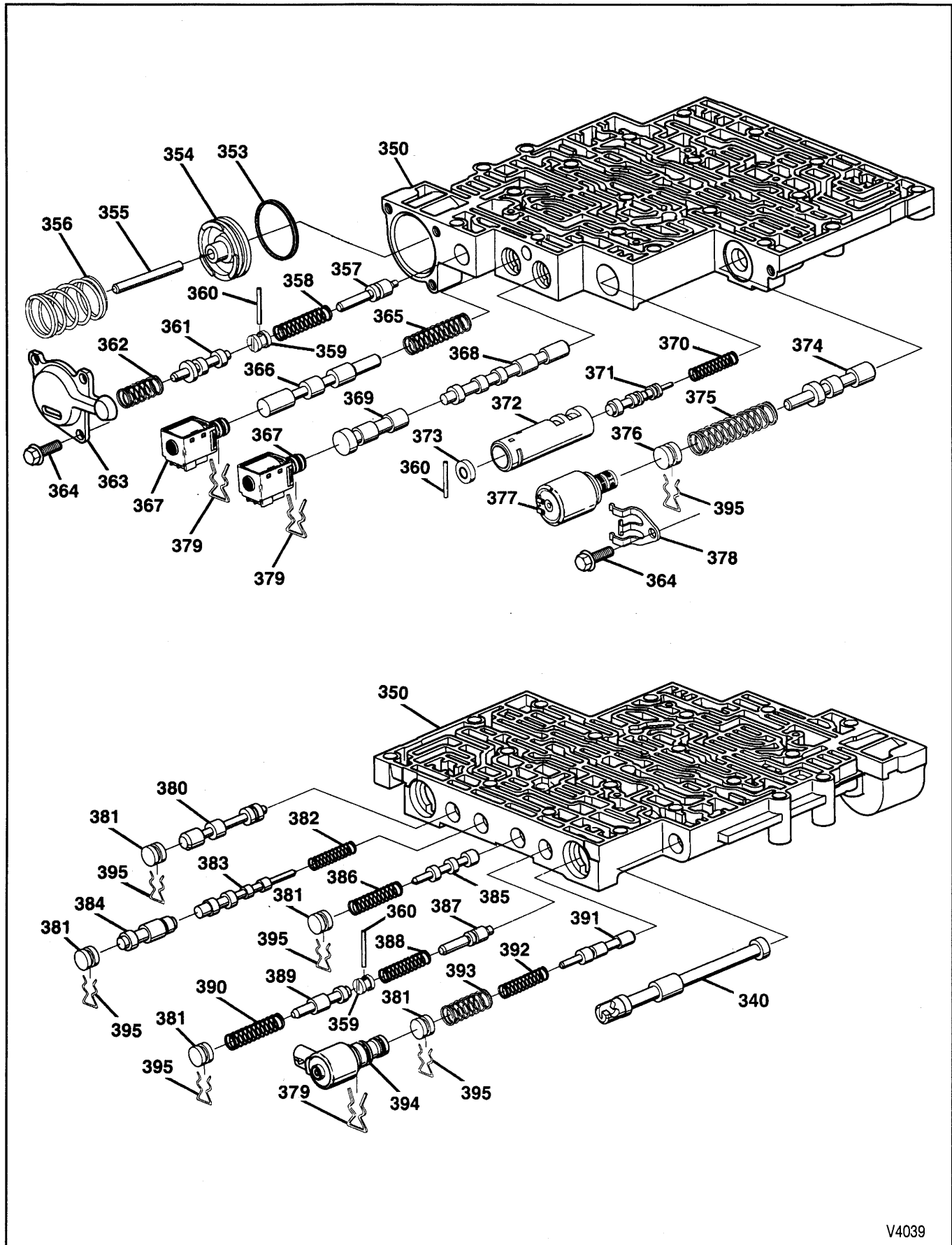


Figure 16—Control Valve Body

- | | |
|--------------------------------------|--|
| 340. VALVE, MANUAL | 373. PLUG, BORE |
| 350. VALVE ASSEMBLY, CONTROL BODY | 374. VALVE, ACTUATOR FEED LIMIT |
| 353. SEAL, FORWARD ACCUMULATOR OIL | 375. SPRING, ACTUATOR FEED LIMIT VALVE |
| 354. PISTON, FORWARD ACCUMULATOR | 376. PLUG, BORE |
| 355. PIN, FORWARD ACCUMULATOR | 377. PRESSURE CONTROL SOLENOID |
| 356. SPRING, FORWARD ACCUMULATOR | 378. RETAINER, PRESSURE CONTROL SOLENOID |
| 357. VALVE, FORWARD ABUSE | 379. RETAINER, SOLENOID |
| 358. SPRING, FORWARD ABUSE VALVE | 380. VALVE, CONVERTER CLUTCH SIGNAL |
| 359. PLUG, BORE | 381. PLUG, BORE |
| 360. PIN, COILED SPRING | 382. SPRING, 4-3 SEQUENCE VALVE |
| 361. VALVE, LOW OVERRUN | 383. VALVE, 4-3 SEQUENCE |
| 362. SPRING, LOW OVERRUN VALVE | 384. VALVE, 3-4 RELAY |
| 363. COVER, FORWARD ACCUMULATOR | 385. VALVE, 3-4 SHIFT |
| 364. BOLT, FORWARD ACCUMULATOR COVER | 386. SPRING, 3-4 SHIFT VALVE |
| 365. SPRING, 1-2 SHIFT VALVE | 387. VALVE, REVERSE ABUSE |
| 366. VALVE, 1-2 SHIFT | 388. SPRING, REVERSE ABUSE VALVE |
| 367A. 1-2 SHIFT SOLENOID (A) | 389. VALVE 3-2 DOWNSHIFT |
| 367B. 2-3 SHIFT SOLENOID (B) | 390. SPRING, 3-2 DOWNSHIFT VALVE |
| 368. VALVE, 2-3 SHIFT | 391. VALVE, 3-2 CONTROL |
| 369. VALVE, 2-3 SHUTTLE | 392. SPRING, 3-2 CONTROL VALVE |
| 370. SPRING, 1-2 ACCUMULATOR VALVE | 393. SPRING, BORE PLUG |
| 371. VALVE, 1-2 ACCUMULATOR | 394. 3-2 CONTROL SOLENOID |
| 372. SLEEVE, 1-2 ACCUMULATOR VALVE | 395. RETAINER, BORE PLUG |

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Figure 17—Control Valve Body (Key)



Inspect

- All valves and bushings for:
 - Porosity.
 - Scoring.
 - Nicks.
 - Scratches.
- Springs for damaged or distorted coils.
- Valve body casting for: -- Porosity. -- Cracks. -- Interconnected oil passages. -- Damaged machined surfaces.



Assemble

- Control valve assembly (350) exactly as shown.
 - Notice the position of the valve lands and bushing passages.
 - Position the pressure control solenoid so the connector tabs face outward.

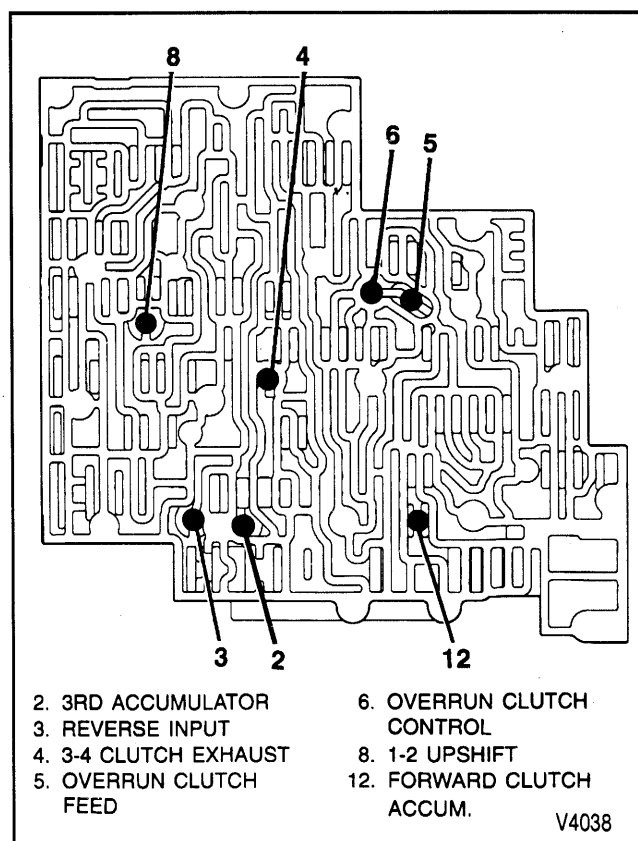


Install or Connect (Figure 11, 13, 14, 18, and 19)

NOTICE: For steps 4, 5, and 9, refer to "Notice" on page 7A14B-1.

1. Checkballs into the valve body assembly (350) (figure 18).

- Retain with Transjel® J 36850 or equivalent.



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Figure 18—Control Valve Body Checkball Locations

7A14B-14 4L60-E ON-VEHICLE SERVICE

2. Valve body assembly (350).
 - Connect the manual valve link (89) to the inside detent lever (88) (figure 14).
 - Be careful not to damage screens when installing the valve body assembly.
3. Wiring harness, manual spring assembly (63), pressure switch assembly (69), and all remaining valve body bolts (figure 13).

NOTICE: Torque valve body bolts in a spiral pattern starting from the center. If bolts are torqued at random, valve bores may be distorted and inhibit valve operation.

4. TCC solenoid and bolts (68) (figure 11).

Tighten

- Bolts (68) to 11 N.m (97 lbs. in.)
 - Wiring harness connections to electrical components.
 - The pressure control solenoid (377) has two different colored connectors. The black connector should be installed on the tab farthest from the valve body.
5. Parking bracket.

Tighten

- Bolts to 31 N.m (23 lbs. ft.).
6. The 1-2 accumulator piston seal (61) onto the 1-2 accumulator piston (61) (figure 19).
 7. The 1-2 accumulator piston (61) into the 1-2 accumulator cover and pin assembly (62).

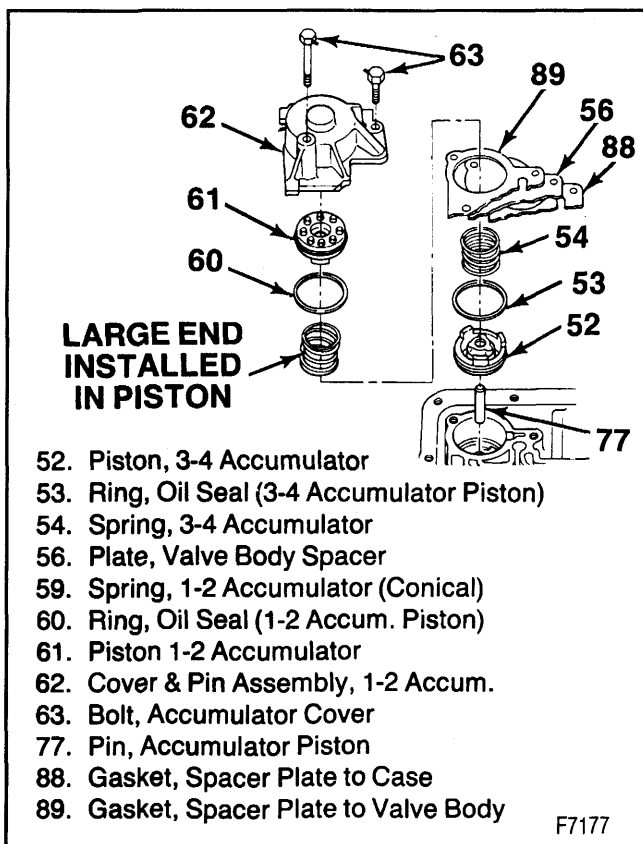


Figure 19—1-2 and 3-4 Accumulator Assembly

- The three legs on the piston must face toward the case when installed.
8. The 1-2 accumulator spring (59) on the piston (61).
 9. The 1-2 accumulator cover and pin assembly (62) onto the case.

Tighten

- Bolts (63) to 11 N.m (97 lbs. in.).
10. New filter and gasket, pan bolts and new fluid. Refer to "Changing the Fluid and Filter."
 11. Lower vehicle.
 12. Negative battery cable.

Adjust

- Fluid level. Refer to SECTION 7A14A.
- Use Dexron® 3 or Dexron® IIE Automatic Transmission Fluid.
- Inspect for leaks.

REAR EXTENSION OIL SEAL

Remove or Disconnect (Figure 20)

1. Raise the vehicle and suitably support.
2. Transmission fluid. Refer to "Changing the Fluid and Filter."
3. Propeller shaft. Refer to SECTION 4A.
4. Seal.

Install or Connect (Figure 20)

Tool Required:

J 21426 Extension Housing Oil Seal Installer.

1. New seal using J 21426.
 - Coat the outer edge of the seal case with a non-hardening sealer.
2. Propeller shaft. Refer to SECTION 4A.
 - Lower the vehicle.
3. New transmission fluid. Refer to "Specifications."

ACCUMULATOR ASSEMBLY

Remove or Disconnect (Figures 19 and 21)

- Raise the vehicle and suitably support.
 - Place a drain pan under the transmission oil pan.
1. Transmission oil pan.
 2. Accumulator cover bolts (63).
 3. Cover (62).

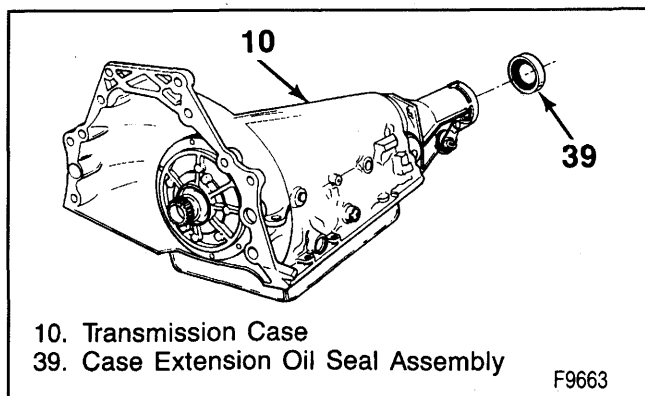


Figure 20—Rear Oil Extension Seal

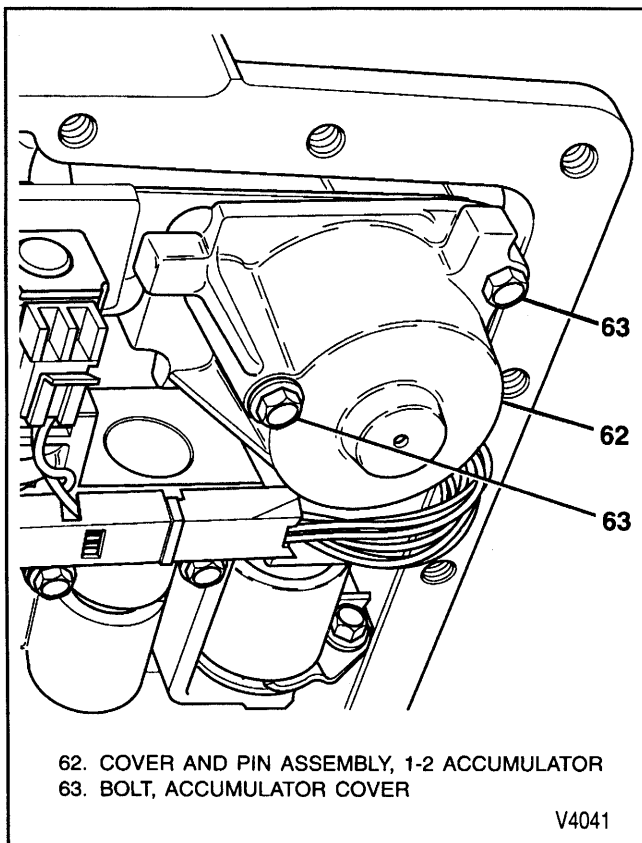


Figure 21—Accumulator Cover Location

4. 1-2 accumulator piston (61).
5. Oil seal ring (60).
6. 1-2 accumulator spring (59).
7. Spacer plate from the valve body gasket (89).
8. Valve body spacer plate (56).
9. Spacer plate case gasket (88).
10. 3-4 accumulator spring (54).
11. Oil seal ring (53).
12. 3-4 accumulator piston (52).
13. Accumulator piston pin (77).

Inspect

- The 1-2 accumulator cover (62) for:
 - Porosity or damage.
 - Scored piston wall.
 - Plugged oil passage.
- The 1-2 accumulator piston (61) and the 3-4 accumulator piston (52) for:
 - Porosity.
 - Ring groove damage.
 - Pin hole damage.
- 1-2 accumulator spring (59) and 3-4 accumulator spring (54) for distortion or damage.
- Spacer plate (56) and gaskets (88 and 89) for damage.

Install or Connect (Figures 19 and 21)

NOTICE: For steps 12 and 15, refer to “Notice” on page 7A14B-1.

1. Accumulator piston pin (77).

2. 3-4 accumulator piston (52).
3. Oil seal ring (53).
4. 3-4 accumulator spring (54).
5. Spacer plate to the case gasket (88).
6. Valve body spacer plate (56).
7. Spacer plate to the valve body gasket (89).
8. 1-2 accumulator spring (59).
9. Oil seal ring (60).
10. 1-2 accumulator piston (61).
11. Cover (62).
12. Accumulator cover bolts (63).

Tighten

- Bolts (63) to 11 N.m (97 lbs. in.).

13. Transmission oil pan (73).
14. Transmission pan gasket (72).
15. Transmission oil pan to case bolts (74).

Tighten

- Bolts (74) to 11 N.m (97 lbs. in.).

16. New transmission fluid. Refer to “Specifications.”

VEHICLE SPEED SENSOR REPLACEMENT

Remove or Disconnect (Figure 22)

Tool Required:

J 38417 Speed Sensor Remover and Installer

1. Harness connector.
2. Bolt (35).
3. Vehicle speed sensor (36).
- Have a suitable container to catch the fluid.
4. O-ring seal (37).

Install or Connect

Tool Required:

J 38417 Speed Sensor Remover and Installer

1. New speed sensor (36) and O-ring seal (37).
- Coat the seal with a thin film of transmission fluid.

NOTICE: Refer to “Notice” on page 7A14B-1.

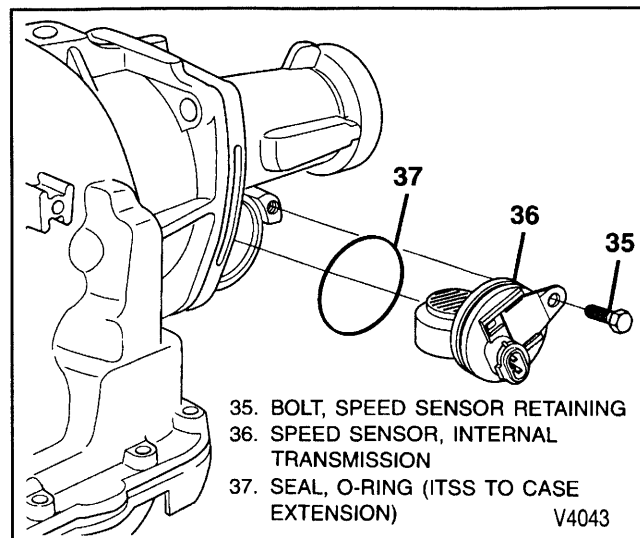


Figure 22—Vehicle Speed Sensor

2. Bolt (35).



Tighten

- Bolt (35) to 11 N.m (97 lbs. in.).

3. Harness connector.

- Refill fluid as required.

TRANSMISSION REPLACEMENT

Perform steps 1-10, if the transmission is being lowered for clearance only.



Remove or Disconnect (Figure 23 and 24)

Tool Required:

J 21366 Converter Holding Strap

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle and suitably support.
2. Transmission fluid. Refer to "Changing the Fluid and Filter."
3. Shift linkage. Refer to "Shift Linkage."
4. Relieve fuel system pressure and remove fuel lines. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.
5. Propeller shaft. Refer to SECTION 4A.
 - Front prop shaft from the transfer case (if used).
6. Transfer case and shifter (if used). Refer to SECTION 7D.
7. The support bracket at the catalytic converter.
8. Any other components as needed for clearance.
 - Support the transmission with a transmission jack.
9. Transmission crossmember.



Important

- Do not stretch or damage any cables, wires, or other components when lowering the transmission.
10. Lower the transmission far enough to provide clearance to reach other components.
 11. Dipstick tube (221) and seal.
 - Cover the opening in the transmission.
 12. Speedometer harness connector.
 13. Electrical connectors from the transmission.
 14. Transmission cooler lines (223).
 - Cap all openings in the transmission and the lines.
 15. Transmission support braces (222).
 - Note the location of the braces, they must be installed in the same positions.
 16. Converter housing cover (228).
 - Mark the flywheel and torque converter alignment.
 17. Screws (230).



Important

- Support the engine with a jack stand before disconnecting the transmission.

18. Screws (226).

- Note the location of any brackets or clips and move them aside.
- Slide the transmission straight back of the locating pins (A) and install J 21366.

19. Transmission (225) from the vehicle.



Clean

- Transmission case using a solvent dampened cloth. Do not allow solvent to enter the transmission. Air dry.
- All hardware and flywheel cover using solvent. Air dry.



Inspect

- All parts for wear and damage.
- All seals and fittings for signs of leakage.
- Torque converter for stripped or broken weld nuts or screw holes.
- Transmission case for porosity.



Install or Connect (Figure 23 and 24)

NOTICE: For steps 2, 3, and 10, refer to "Notice" on page 7A14B-1.

- If the transmission was lowered for clearance only, perform steps 11-17.

Tool Required:

J 21366 Converter Holding Strap

1. Transmission (225).
 - A. Make sure the torque converter is seated properly and that J 21366 is in place.
 - B. Support the transmission with a transmission jack.
 - C. Raise the transmission into place and remove J 21366.
 - D. Slide the transmission straight onto the locating pins (A) while lining up the marks on the flywheel and torque converter.



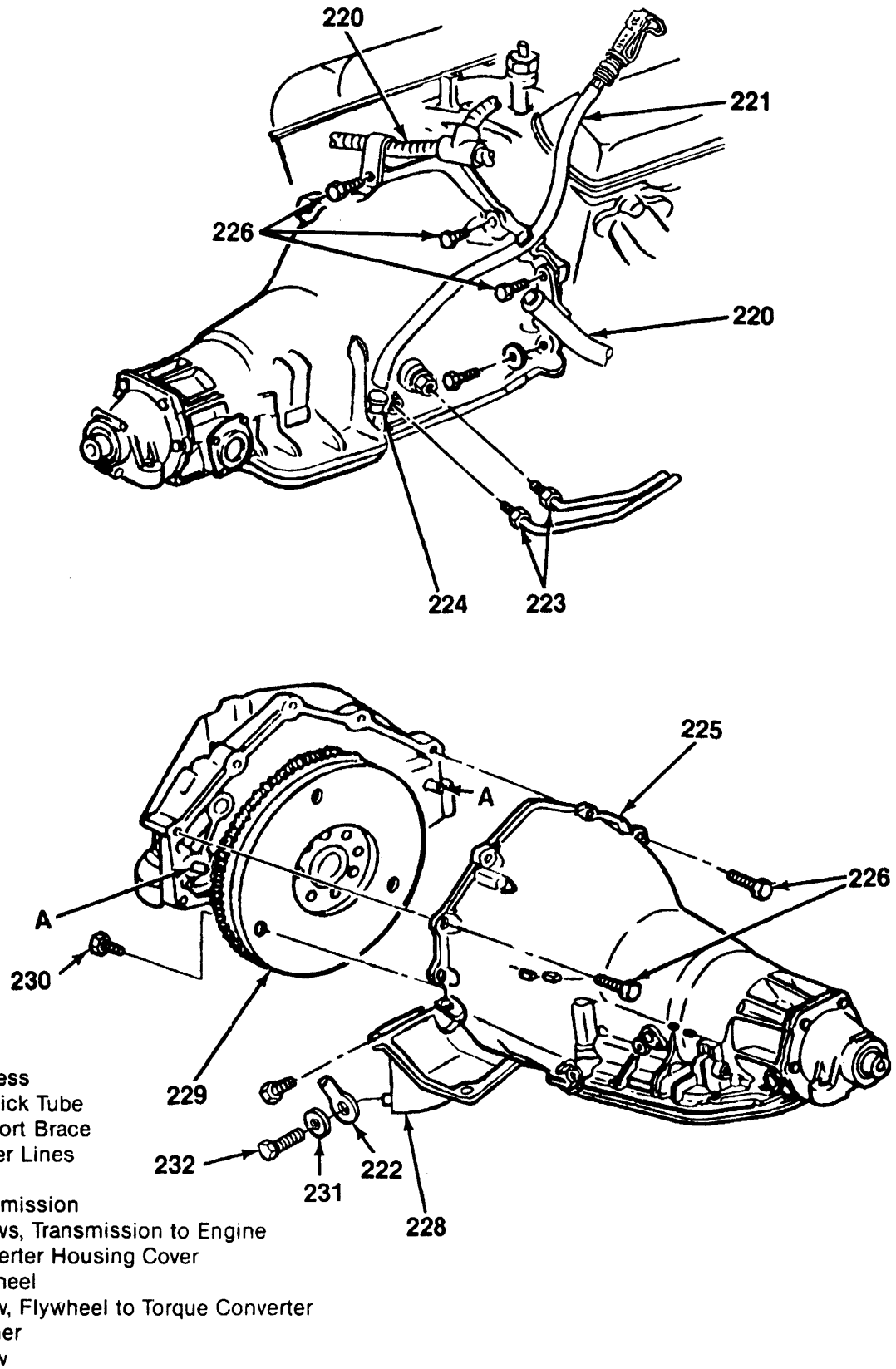
Important

- The torque converter must be flush onto the flywheel and rotate freely by hand.
2. Screws (226).
 - All brackets, clips, and harnesses must be positioned as they were when removed.
 - Do not install the dipstick tube or the transmission support brace screws.
 3. Screws (230).



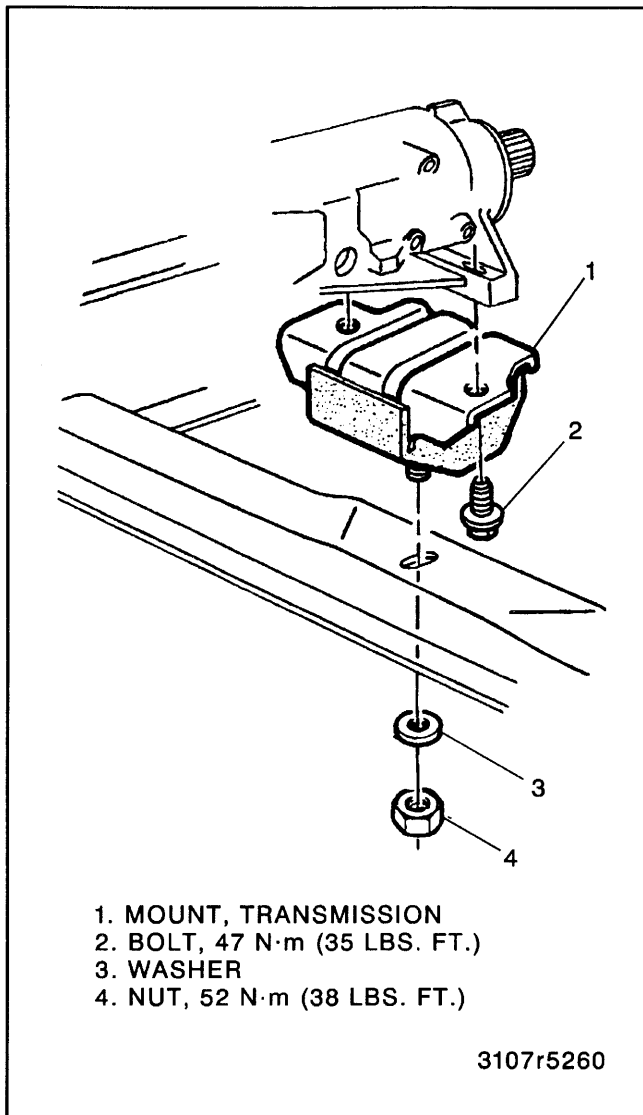
Tighten

- Screws finger tight to ensure proper converter seating.
 - Screws (230) to 68 N.m (50 lbs. ft.).
 - Remove the engine hoist or jack.
4. Converter housing cover (228).
 - Hook the cover under the lip of the engine oil pan.



F3529

Figure 23—Transmission and Components



1. MOUNT, TRANSMISSION
2. BOLT, 47 N·m (35 LBS. FT.)
3. WASHER
4. NUT, 52 N·m (38 LBS. FT.)

3107r5260

Figure 24—Transmission Mount

5. Transmission support braces (222).
 - The braces must be installed in the positions from which they were removed.
6. Transmission cooler lines (223). Refer to "Transmission Cooler Flushing."
 - Uncover the openings.
 - Do not twist or bend the lines.
7. Speedometer harness connector.
8. Electrical connectors to the transmission.
9. Dipstick tube (221) with a new seal.
 - Uncover the opening and install the seal first.
10. Screw (226).



Tighten

- Screw (226) to 32 N·m (23 lbs. ft.).

11. Transmission in place.



Important

- Do not pinch or damage any cables, wires, or other components when lowering the transmission.

12. Transmission crossmember and transmission mount.
13. Any components that were removed for clearance.
 - Remove the transmission jack.
14. The support bracket at the catalytic converter.
15. Transfer case and shifter (if used). Refer to SECTION 7D.
16. Propeller shaft. Refer to SECTION 4A.
 - Front propeller shaft to the transfer case, if used.
17. Fuel lines. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.
18. Shift linkage.
 - Lower the vehicle.
19. New transmission fluid. Refer to SECTION 7A14A.
20. Negative battery cable.

TRANSMISSION COOLER FLUSHING

Transmission oil cooler flushing must be performed whenever a transmission is removed for service. It is essential to flush the oil cooler after transmission installation, after a major overhaul, if fluid contamination is suspected, or in any case of pump or torque converter replacement.

To ensure the complete transmission system service it is recommended that the flush procedure be performed after the overhauled or replacement assembly has been reinstalled in the vehicle.

Tools Required:

J 35944 Cooler Flushing Tool

J 35944-20 or J 35044-CSE Biodegradable Flushing Solution

Preparation

1. After the overhauled or service replacement transmission is reinstalled in the vehicle, do not reconnect the oil cooler pipes.
2. Remove the fill cap on J 35944 and fill the can with 0.6 liter (20-21 ounces) of flushing solution. Do not overfill or the tool will need to be recharged with air before the backflush. Follow the manufacturer's suggested procedures for proper handling of the solution.

NOTICE: Do not substitute with any other solution. The flushing tool is designed to use only this concentrate. Use of any other solution can result in damage to the tool, cooler components, or improper flushing of the cooler.

3. Secure the fill cap and pressurize the flusher can with shop air to 550-700 kPa (80-100 psi).

CAUTION: Shop air supply must be equipped with a water/oil filter and not exceed 825 kPa (120 psi), or personal injury may result.

4. Connect the discharge hose to the transmission end of the oil cooler pipe that goes to the top fitting at the radiator.
5. Clip the discharge hose onto the oil drain container.
6. Mount the flushing tool to the undercarriage of the vehicle with the hook provided and connect the hose from the flushing tool to the remaining oil cooler pipe.

7. With the water valve on the tool in the "OFF" position, connect the water hose from the water supply to the tool.
8. Turn on the water supply at the faucet.

Initial Flush

9. Switch the water valve on the tool to the "ON" position. Allow the water to flow through the oil cooler for 10 seconds to remove the supply of transmission fluid in the system.

CAUTION: If water does not flow through the oil cooler (system is completely plugged), do not continue flushing procedure. Turn the water off immediately and inspect the pipes and cooler for restrictions and repair, or personal injury could result.

10. Switch the water valve on the tool to the "OFF" position and clip the discharge hose onto a 5 gallon pail with a lid, or position a shop towel over the end of the discharge hose to prevent splash. The discharge will foam vigorously when the solution is introduced into the water stream.
11. Switch the water valve on the tool to the "ON" position and depress the trigger to mix the flushing solution into the water flow. Use the bale clip provided on the handle to hold the trigger down.
12. Flush the oil cooler with water and solution for 2 minutes. During this flush, attach the air supply to the air valve located on the plumbing of the tool for 3 to 5 seconds at the end of every 15-20 second interval to create a surging action.

CAUTION: Shop air supply must be equipped with a water/oil filter and not exceed 825 kPa (120 psi), or personal injury could result.

13. Release the trigger and switch the water valve on the tool to the "OFF" position.
14. Disconnect both hoses from the oil cooler pipes.
Backflush
15. Connect hoses to the oil cooler pipes opposite from the initial flush procedures to perform a backflush.
16. Repeat steps 11 and 12.
17. Release the trigger and allow water only to rinse the oil cooler for 1 minute.
18. Switch the water valve on the tool to the "OFF" position and turn the water supply off at the faucet.
19. Attach the air supply to the air valve located on the plumbing of the tool and dry the system out with air for at least 2 minutes. Longer if moisture is visible exiting from the oil cooler line discharge hose. Use an air chuck clip, if available, to secure the air chuck onto the air valve for ease of operation.

NOTICE: Excessive residual moisture can cause corrosion in the oil cooler or cooler pipes and can damage the transmission. If steps 20 through 23 cannot be completed at this time, rinse the oil cooler and cooler pipes with transmission fluid. Complete steps 20 through 23 after reinstallation of transmission.

20. Connect the cooler feed pipe to the transmission bottom connector.
21. If not already connected, attach the discharge hose to the cooler return pipe (top connector) and place the other end into an appropriate drain container.
22. After filling the transmission with automatic transmission fluid, start the engine and run for 30 seconds. This will remove any residual moisture from the oil cooler and cooler pipes, protect all components from corrosion, and check the flow rate through the cooler. A minimum of 2 quarts must be obtained during this 30 second run. If fluid flow is insufficient, check the fluid flow out of the transmission by disconnecting the oil cooler feed line at the radiator and restarting the engine.

Do the following according to flow rate:

- Insufficient Feed Flow: Inspect the transmission for cause.
 - Sufficient Feed Flow: Inspect oil cooler pipes and fittings for restrictions or leaks and repeat the oil cooler flushing procedure. Repeat the check of fluid flow out the return line and if flow is still inhibited, replace the oil cooler.
23. Remove the discharge hose, reconnect the cooler return pipe to the transmission and refill the unit to the proper fluid level. Refer to SECTION 7A14A.

Tool Cleaning - Every Third Use

24. Disconnect the water supply hose from the tool.
25. Bleed air pressure from the can, remove the fill cap, return any unused solution to the container, and rinse the can out with water. Do not store the tool with solution in the tank.
26. Loosen the large coupling nut and remove the plumbing from the tank.
27. Remove the screen from the plumbing and wash it with water.
28. Use the cleaning pin to remove any material in the solution orifice. The orifice is located in the plumbing below the screen.
29. Reconnect the plumbing and fill the can half with water, secure the fill cap, and pressurize the can to 550-700 kPa (80-100 psi).
30. Aim the tool into the 5 gallon pail or floor drain and depress the trigger to allow the water from the can to flow through the solution orifice for 30 seconds to ensure proper cleaning.
31. Bleed air pressure from can, remove the fill cap, and empty the can.
32. Reconnect fill cap to the flushing tool.

SHIFT INDICATOR REPLACEMENT

For shift indicator replacement, refer to SECTION 8C.

SHIFT INDICATOR ADJUSTMENT

For shift indicator adjustment, refer to SECTION 8C.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N-m	Ft. Lbs.	In. Lbs.
Accumulator Cover to Case (M6-1.0 x 35.0).....	11	—	97
Auxiliary Valve Body to Case.....	11	—	97
Case Extension to Case.....	34	25	—
Connector Cooler Pipe.....	38	28	—
Converter Housing Cover.....	10	—	88
Converter to Flywheel.....	63	46	—
Cooler Lines to Radiator.....	24	18	—
Cooler Lines to Transmission.....	24	18	—
Crossmember to Frame.....	77	56	—
Detent Spring to Valve Body.....	22	16	—
Filler Tube To Engine.....	32	23	—
Manual Shaft to Inside Detent Lever.....	31	23	—
Oil Passage Cover to Case.....	11	—	97
Pressure Plugs (1/8-27).....	11	—	97
Pressure Plugs (1/4-18).....	24	18	—
Pressure Switches.....	11	—	97
Solenoid Assembly to Pump.....	11	—	97
Shift Linkage.....	28	20	—
Swivel to Equalizer Lever.....	28	20	—
Shift Lever to Transmission.....	30	22	—
Bracket to Frame.....	26	19	—
Transmission Oil Pan to Case.....	11	—	97
Transmission Rear Mount to Crossmember.....	52	38	—
Transmission Support Braces.....	60	44	—
Transmission to Engine.....	32	23	—
Valve Body to Case.....	11	—	97

LUBRICATION SPECIFICATIONS

Capacity**—Pan Removal**

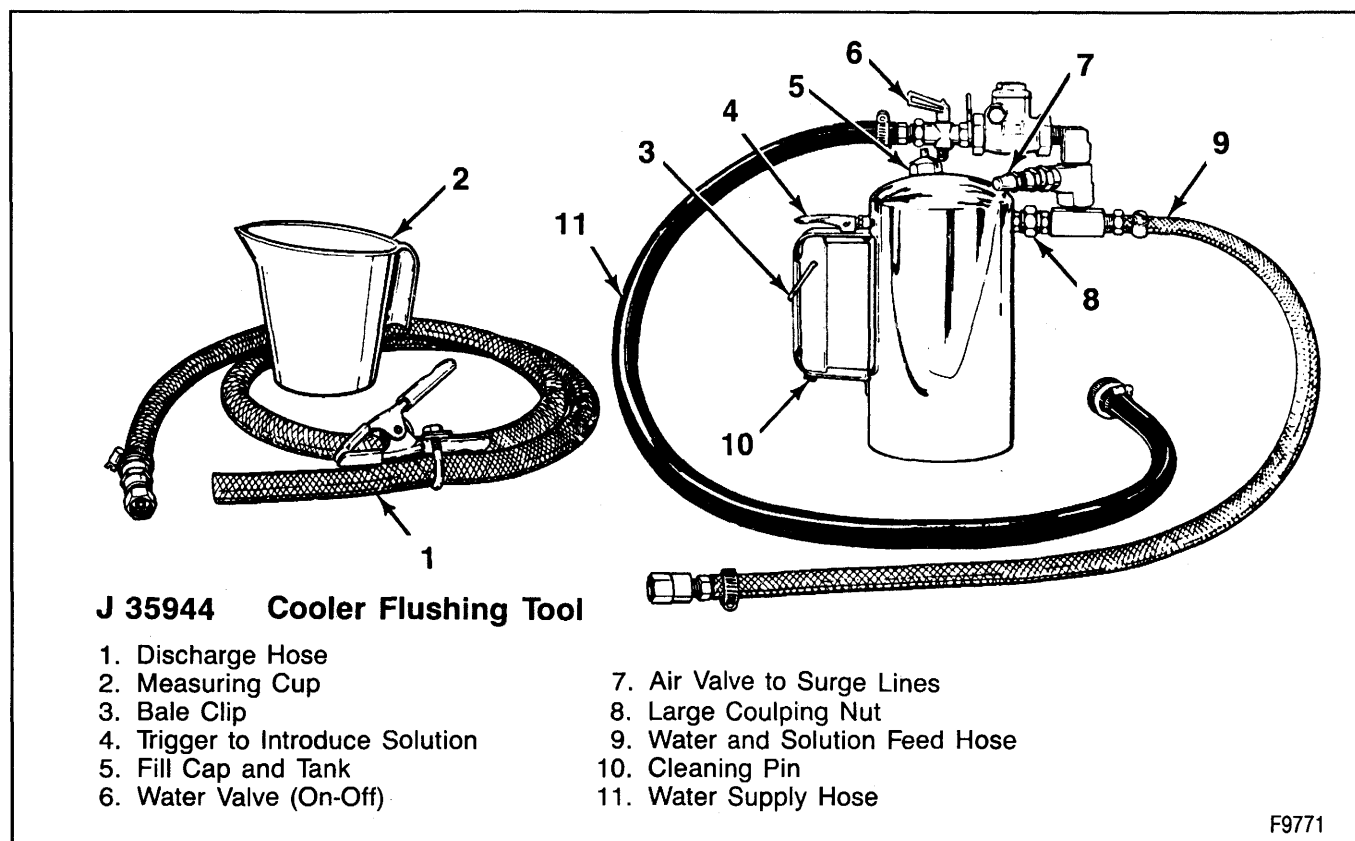
4L60-E.....	4.7 L	5 qts.
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—Overhaul

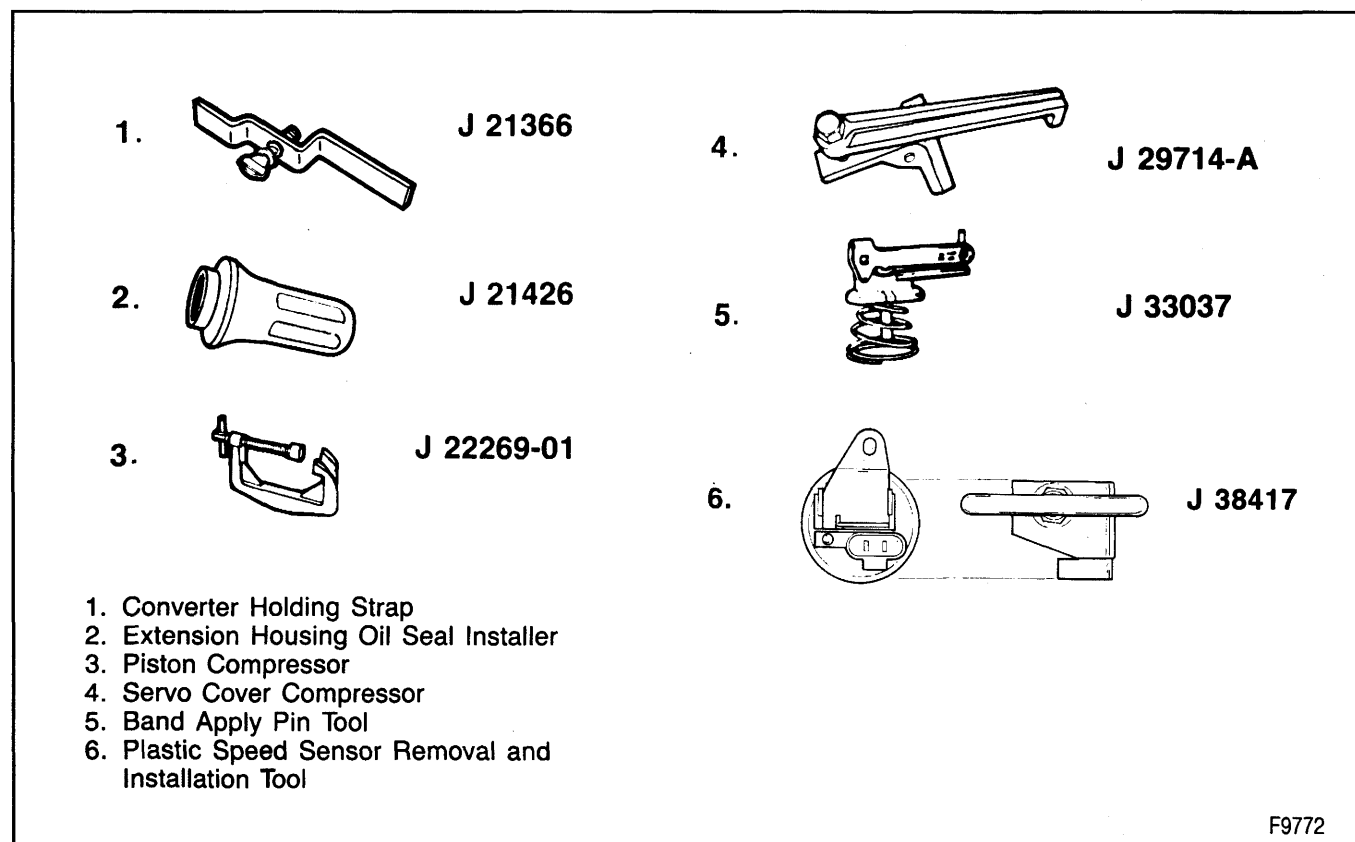
4L60-E.....	10.6 L	11 qts.
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Type Recommended.....	DEXRON®3 or DEXRON®II E Transmission Fluid
	T3054

SPECIAL TOOLS



F9771



F9772

NOTES

SECTION 7A14C

**4L60-E AUTOMATIC TRANSMISSION
DIAGNOSTIC CODES**

For information about the 4L60-E automatic transmission diagnostic codes, refer to the Driveability, Emission, and Electrical Diagnosis Manual for these models.

7A14C-2 4L60-E AUTOMATIC TRANSMISSION DIAGNOSTIC CODES

SECTION 7A-17A

HYDRA-MATIC 4L80-E

AUTOMATIC TRANSMISSION DIAGNOSIS

RPO MT1

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GENERAL DESCRIPTION

Figures 1 and 2

The HYDRA-MATIC 4L80-E is a fully automatic rear wheel drive electronically controlled transmission. It provides four forward ranges including overdrive.

The major components of this unit are:

- Torque converter with converter clutch and dual stators.
- Front and rear band assemblies.
- Forward, Intermediate, Direct, Fourth and Overdrive multiple disc clutches.
- Three planetary gear sets.
- Overdrive and Lo roller clutches.
- Intermediate spray clutch.
- Control valve assembly with two electronic shift solenoids.
- Input and output speed sensors.
- Bolt on case extension.

Oil pressure is supplied by a gear type oil pump. Oil pressure is regulated by a pressure control solenoid, and shift points are controlled by shift solenoids via PCM operation. The torque converter clutch apply and release is controlled by a pulse width modulated solenoid.

A HYDRA-MATIC 4L80-E automatic transmission has a metal identification nameplate attached to the case exterior (figure 2). This information will assist in the servicing and determination of replacement parts when ordered through a GM parts catalog.

Additional transmission identification is provided on the Service Parts Identification label. The label contains information on the regular production options (RPO) as well as standard and mandatory options. This label is affixed to the inside of each vehicle at the assembly plant. Refer to GENERAL INFORMATION (SECTION 0A) for label location and additional information.

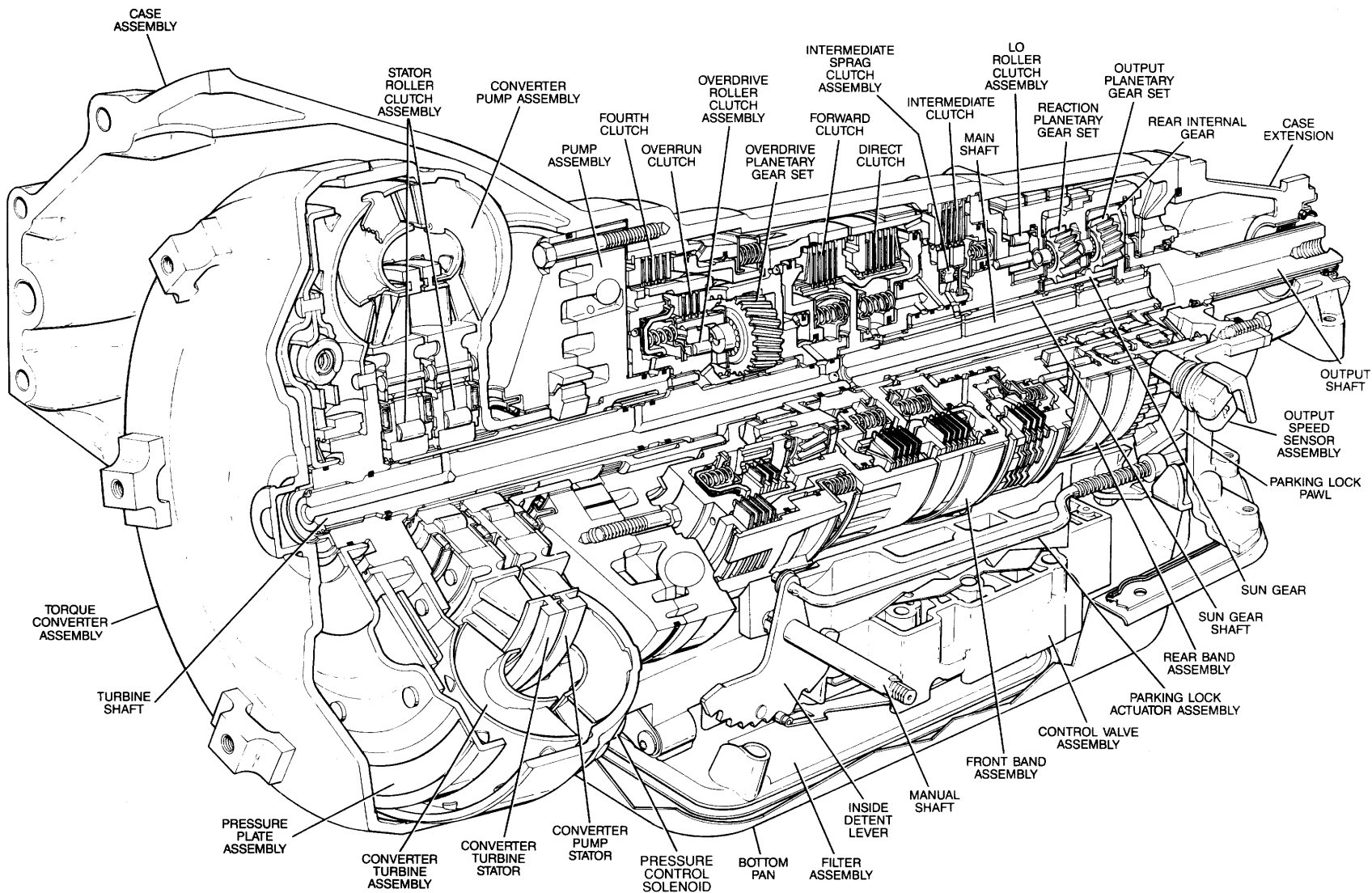


Figure 1 HYDRA-MATIC 4L80-E Transmission

RH0001-4L80-E

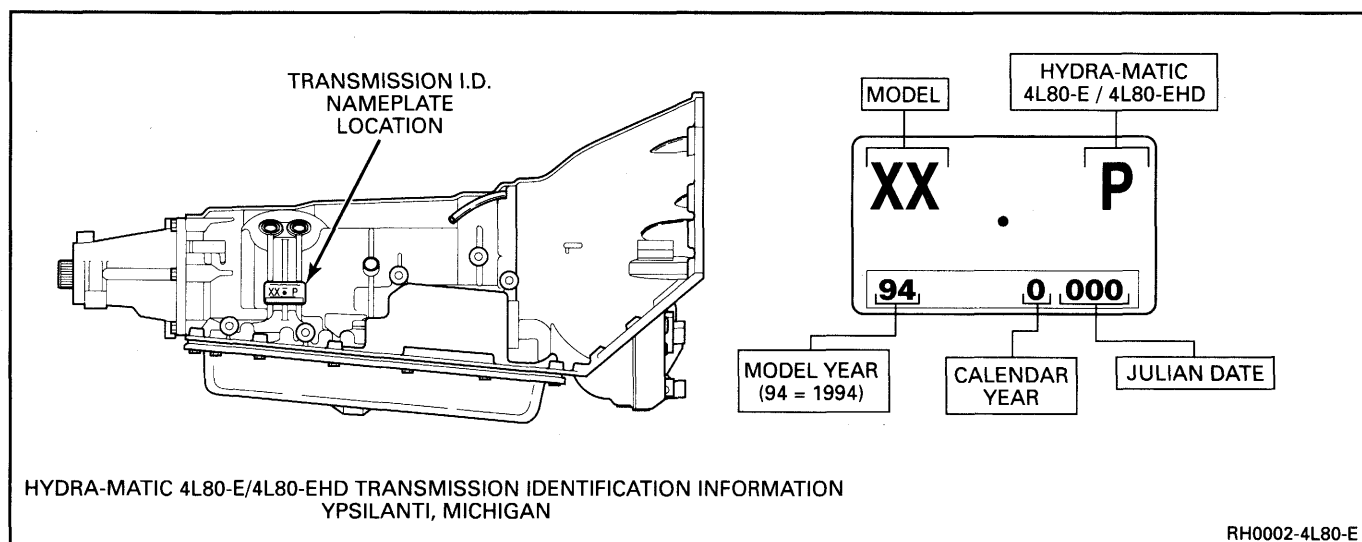


Figure 2 Transmission Identification Information 4L80-E

DIAGNOSIS INFORMATION

ELECTRICAL/GARAGE SHIFT TEST

This preliminary test should be performed before a hoist or road test to make sure electronic control inputs are connected and operating. If the inputs are not checked before operating the transmission, a simple electrical condition could be misdiagnosed as a major transmission condition. Refer to Figure 15 for an example of Tech 1 information.

A scan tool provides valuable information and must be used on the HYDRA-MATIC 4L80-E transmission for accurate diagnosis.

1. Move gear selector to "Park" (P) and set the parking brake.
2. Connect scan tool to DLC terminal.
3. Start engine.
4. Connect power to scan tool.
5. Verify that the following signals are present:
 - INPUT SPEED.
 - OUTPUT SPEED.
 - VEHICLE SPEED.
 - PRNDL SELECT.
 - CURRENT GEAR.
 - DESIRED PRESSURE CONTROL SOL.
 - ACTUAL PRESSURE CONTROL SOL.
 - COOLANT TEMPERATURE.
 - TRANSMISSION TEMPERATURE.
 - THROTTLE ANGLE.
 - TCC DUTY CYCLE.
 - SYSTEM VOLTAGE.
 - BRAKE SWITCH.
6. Monitor the BRAKE SWITCH signal while tapping the brake pedal with your foot.
 - The BRAKE SWITCH should be on when the brake pedal is depressed, and come off when the brake pedal is released.

7. Monitor the PRNDL SELECT signal and move the gear selector through all the ranges.
 - Verify that the PRNDL SELECT value matches the gear range indicated on the instrument panel or console.
 - Gear selections should be immediate and not harsh.
8. Move gear selector to neutral and monitor the THROTTLE ANGLE signal while increasing and decreasing engine rpm with the accelerator pedal.
 - THROTTLE ANGLE should increase with engine rpm.

HOIST TEST PROCEDURE

Since the HYDRA-MATIC 4L80-E is electronically controlled, road load is not needed to automatically shift the transmission. A hoist test can often be used in place of a road test if the problem is suspected to be in the electrical system.

A hoist test can be used to:

- Verify shift points.
- Test TCC operation.
- Test solenoid operation.
- Test gear ratios.
- Test input and output speed sensor assemblies.

The hoist test allows a line pressure check to be performed while the test equipment remains outside of the vehicle. The technician can direct more attention towards testing since the vehicle is not being driven on the road.

Upshifts and Torque Converter Clutch (TCC) Apply

The vehicle computer calculates upshift points based on two inputs: percent THROTTLE ANGLE and VEHICLE SPEED. When the computer says a shift should occur, an electrical signal is sent to the shift solenoids which in turn move the valves to perform the upshift.

The shift speed charts have been updated to reference THROTTLE ANGLE instead of “min throttle” or “wot” to make shift speed measurement more uniform and accurate. A scan tool is necessary to monitor THROTTLE ANGLE.

Some scan tools have been programmed to measure and record shift point information. Check the instruction manual to see if this test is available.

With gear selector in D4:

1. Look at the shift speed chart contained in this section and choose a percent throttle angle of 15 or 20.
2. Set up the scan tool to monitor THROTTLE ANGLE and VEHICLE SPEED.
3. Accelerate to the chosen throttle angle and hold the throttle steady.
4. As the transmission upshifts, note the shift speed for:
 - 2nd gear.
 - 3rd gear.
 - 4th gear.

Important

- Shift speeds may vary due to slight hydraulic delays responding to electronic controls. A change from the original equipment tire size also affects shift speeds.

Note when TCC applies. This should occur in third or fourth gear. If the apply is not noticed by an rpm drop, refer to the “Preliminary Torque Converter Clutch Diagnosis” information contained in this section.

Important

- The TCC will not apply unless the **engine** coolant has reached a minimum operating temperature.
5. Repeat steps 1-4 using several different throttle angles.

Part Throttle Detent Downshift

At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, quickly increase throttle angle.

Verify that:

- TCC releases.
- Transmission downshifts to 3rd gear immediately.
- 1-2 solenoid turns off.

Full Throttle Detent Downshift

At vehicle speed of 64 to 88 km/h (40 to 55 mph) in fourth gear, quickly increase throttle angle to its maximum position.

Verify that:

- TCC releases.
- Transmission downshifts to 2nd gear immediately.
- 1-2 and 2-3 solenoids turn off.

Manual Downshifts

The shift solenoids do not control the initial downshift during manual downshifts. All manual downshifts are hydraulic. The solenoid states will change during, or slightly after a manual downshift is selected.

1. At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, release the accelerator pedal while moving the gear selector to D3. Observe that:
 - TCC releases.
 - Transmission downshifts to 3rd gear immediately.
 - Engine slows vehicle down.
2. Move gear selector back to D4 and accelerate to 64 to 72 km/h (40 to 45 mph). Release the accelerator while moving the gear selector to D2 and observe that:
 - TCC releases.
 - Transmission downshifts to 2nd gear immediately.
 - Engine slows vehicle down.
3. Move gear selector back to D4 and accelerate to 48 km/h (30 mph). Release the accelerator pedal while moving the gear selector to D1 and observe that:
 - TCC releases.
 - Transmission downshifts to 1st gear immediately.
 - Engine slows vehicle down.

Coasting Downshifts

1. With the gear selector in D4, accelerate to 4th gear with TCC applied.
2. Release the accelerator pedal and lightly apply the brakes. Observe that:
 - TCC releases.
 - Downshifts occur at speeds shown on the shift speed chart.

Manual Gear Range Selection

Upshifts in the manual gear ranges are controlled by the shift solenoids.

Perform the following tests by accelerating at 10-15 percent TP Sensor.

Manual Third (D3)

- With vehicle stopped, move the gear selector to D3 and accelerate to observe:
 - 1-2 shift.
 - 2-3 shift.
 - TCC does not apply.

Manual Second (D2)

1. With vehicle stopped, move gear selector to D2 and accelerate to observe:
 - 1-2 shift.
2. Accelerate to 56 km/h (35 mph) and observe:
 - 2-3 shift does **not** occur.
 - TCC does **not** apply.

Manual First (D1)

- With vehicle stopped, move gear selector to D1. Accelerate to 32 km/h (20 mph) and observe:
 - No upshifts occur.
 - TCC does **not** engage.

Reverse (R)

- With vehicle stopped, move gear selector to R and slowly accelerate to observe:
 - 1-2 solenoid is on.

Use a scan tool to see if any transmission malfunction codes have been set. Refer to “Malfunction Diagnostic Trouble Code (DTC) Diagnosis” in this section and repair the vehicle as directed. After repairing the vehicle, perform the hoist test and verify that the code has not set again.

If the transmission is not performing well and no trouble codes have been set, there may be an intermittent condition. Check all electrical connections for damage or a loose fit. Some scan tools have a snapshot test which can help catch an intermittent condition that doesn't occur long enough to set a code.

You may want to read “Electronic Component Diagnosis” in this section to become familiar with transmission conditions caused by transmission electrical malfunctions.

If no trouble codes have been set and the condition is suspected to be hydraulic, take the vehicle on a road test.

TRANSMISSION DEFINITIONS

The following definitions are being provided to establish a common language and assist the user in describing transmission related conditions.

Throttle Positions

- Minimum Throttle – the least amount of throttle opening required for an upshift.
- Light Throttle – approximately 1/4 of accelerator pedal travel.
- Medium Throttle – approximately 1/2 of the accelerator pedal travel.
- Heavy Throttle – approximately 3/4 of the accelerator pedal travel.
- Wide Open Throttle (WOT) – full travel of the accelerator pedal.
- Full Throttle Detent Downshift – a quick application of the accelerator pedal to its full travel, forcing a downshift.
- Zero Throttle Coastdown – a full release of the accelerator pedal while the vehicle is in motion and in drive range.
- Engine Braking – a condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Shift Conditions

- Bump – a sudden and forceful application of a clutch or band.
- Chuggle – a bucking or jerking condition that may be engine related. May be most noticeable when the converter clutch is engaged. Similar to the feel of towing a trailer.
- Delayed – a condition where a shift is expected but does not occur for a period of time. Samples of this condition could be described as clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle application of the accelerator or when manually downshifting to a lower range. Also defined as “LATE” or, “EXTENDED.”
- Double Bump (“Double Feel”) – two sudden and forceful applications of a clutch or band.
- Early – a condition where the shift occurs before the vehicle has reached a proper speed and tends to labor the engine after the upshift.
- End Bump – a firmer feel at the end of a shift as compared to the feel at the start of the shift. Also defined as “END FEEL” or, “SLIP BUMP.”
- Firm – a noticeable quick application of a clutch or band that is considered normal with a medium to heavy throttle shift. Should not be confused with “HARSH” or “ROUGH.”
- Flare – a quick increase in engine rpm accompanied by a momentary loss of torque. This most generally occurs during a shift. Also defined as “SLIPPING.”
- Harsh (“Rough”) – a more noticeable application of a clutch or band as compared to “FIRM.” This condition is considered undesirable at any throttle position.

- Hunting – a repeating quick series of upshifts and downshifts that cause a noticeable change in engine rpm. An example could be described as a 4-3-4 shift pattern. Also defined as “BUSYNESS.”
- Initial Feel – a distinct firmer feel at the start of a shift as compared to the finish of the shift.
- Late – a shift that occurs when the engine is at a higher than normal rpm for a given amount of throttle.
- Shudder – a repeating jerking sensation similar to “CHUGGLE” but more severe and rapid in nature. This condition may be most noticeable during certain ranges of vehicle speed. May also be used to define the condition after converter clutch engagement.
- Slipping – a noticeable increase in engine rpm without vehicle speed increase. A slip usually occurs during or after initial clutch or band engagement.
- Soft – a slow, almost unnoticeable clutch application with very little shift feel.
- Surge – a repeating engine related feeling of acceleration and deceleration that is less intense than “CHUGGLE.”
- Tie-Up – a condition where two opposing clutches are attempting to application at the same time causing the engine to labor with a noticeable loss of engine rpm.

NOISE CONDITIONS

- Gear Noise – a whine, most noticeable in first gear and reverse that is related to vehicle speed. A gear noise condition may become less noticeable or go away after an upshift.
- Pump Noise – a high pitch whine that increases in intensity with engine rpm. This condition may also be noticeable in “PARK” and “NEUTRAL” operating ranges with the vehicle stationary.

PRELIMINARY CHECKING PROCEDURE

The condition of an automatic transmission not operating properly may be influenced by one, or a combination of the following items:

- Fluid level high/low.
- Engine performance. (Refer to the Driveability, Emission, and Electrical Diagnosis Manual).
- Manual linkage adjustment.
- Internal fluid leaks.

- Electrical system. (Refer to the Driveability, Emission, and Electrical Diagnosis Manual).
- Transmission or other mechanical component. (Refer to SECTION 7A-17B).

NOISE AND VIBRATION ANALYSIS

A noise or vibration that is noticeable when the vehicle is in motion, MAY NOT be the result of the transmission.

If noise or vibration is noticeable in “Park” (P) and “Neutral” (N) with engine at idle, but is less noticeable as rpm increases, the cause may be from poor engine performance.



Inspect

- Tires for:
 - Uneven wear
 - Imbalance
 - Mixed sizes
 - Mixed radial and bias ply. Refer to TIRES AND WHEELS (SECTION 3E).
- Suspension components for:
 - Alignment and wear
 - Loose fasteners
- Engine/transmission mounts for:
 - Damage
 - Loose bolts
- Transmission case mounting holes for:
 - Missing bolts, nuts, studs
 - Stripped threads
 - Cracks
- Flywheel for:
 - Missing or loose bolts
 - Cracks
 - Imbalance. Refer to ENGINE (SECTION 6).
- Torque converter for:
 - Missing or loose bolts or lugs
 - Missing or loose balance weights
 - Imbalance

TRANSMISSION FLUID LEVEL INFORMATION

Checking fluid level, color, and condition at regular intervals will provide early diagnosis information about the transmission. This information may then be used to correct a condition that, if not detected early, could result in major transmission repairs.

When adding or changing fluid, use only DEXRON®-IIE. Refer to MAINTENANCE AND LUBRICATION (SECTION 0B) for maintenance information and servicing intervals.

NOTICE: Do not overfill. Overfilling will cause foaming, loss of fluid, and possible damage to the transmission.

- Fluid level should only be checked when it reaches a normal operating temperature of 82°-93°C (180°-200°F). This temperature is reached after approximately 24 km (15 miles) of driving.
- Fluid color will be red when new. The red dye is added so the assembly plant can identify it as transmission fluid and distinguish it from engine oil or anti-freeze. The red dye is not a indicator of the fluid quality and is not permanent. As the vehicle is driven, the transmission fluid will begin to look darker in color. The color may eventually appear light brown.
- Inaccurate fluid level readings will result if the fluid is checked immediately after the vehicle has been operated under certain conditions.
 - In high ambient temperature above 32°C (90°F).
 - At sustained high speed.
 - In heavy city traffic during hot weather.
 - As a towing vehicle.
 - In commercial service.

TRANSMISSION FLUID CHECKING PROCEDURE

Figure 3

NOTICE: The automatic transmission fluid level must be checked with the vehicle at normal operating temperature 82°-93°C (180°-200°F). Temperature will greatly affect transmission fluid level. If the vehicle is not at normal operating temperature and the proper checking procedures are not followed, the result could be a false reading of the fluid level indicator and an incorrect adjustment of the fluid level.

1. Start engine and drive vehicle for a minimum of 24 km (15 miles), or until normal operating temperature is reached.
2. Park vehicle on level ground.
3. Move gear selector to "PARK."
4. Apply park brake and block wheels.
5. Let the vehicle idle for 3 minutes with accessories off.
6. Check fluid level, color, and condition.

LINE PRESSURE CHECK PROCEDURE

Figure 4

This test can be performed during the hoist or road test. It is easier to check pressures during the hoist test because the tubing and pressure gage can remain outside of the vehicle, and won't be damaged by road conditions or debris. The technician can diagnose more quickly on the hoist since the driver doesn't have to watch the road.

The HYDRA-MATIC 4L80-E uses a gear type oil pump to produce hydraulic pressure, and a pressure control solenoid to control that pressure after it leaves the pump. The pressure control solenoid is controlled by an electrical signal that ranges from 0-1 amp. One amp corresponds to a minimum line pressure (not 0 psi) and zero amps corresponds to a maximum line pressure.

For reverse, a reverse boost valve increases the line pressure.

ROAD TEST PROCEDURE

Figures 5 and 6

- Perform the road test using a scan tool
- Compare the results of this test with results from the hoist test.
- This test should only be performed when traffic and road conditions permit.
- Observe all traffic safety regulations.
 1. Start engine.
 2. Depress brake pedal.
 3. Move gear selector from:
 - Park to Reverse.
 - Reverse to Neutral.
 - Neutral to D4.



Important

- Gear selections should be immediate and not harsh.
4. Perform the same test procedure as instructed previously in the hoist test:
 - Upshifts and TCC Apply.
 - Part Throttle Detent Downshift.
 - Full Throttle Detent Downshift.
 - Manual Downshifts.
 - Coasting Downshifts.
 - Manual Gear Range Selection.

Use a scan tool to see if any transmission malfunction codes have been set. Refer to the "Malfunction Diagnostic Trouble Code (DTC) Diagnosis" in this section and repair the vehicle as directed. After repairing the vehicle, perform the road test and verify that no codes have been set again.

If no codes have been set and the condition remains, refer to the "Diagnosis Charts" contained in this section.

If the condition is suspected to originate in the torque converter, refer to "Torque Converter Clutch (TCC) Diagnosis" later in this section.

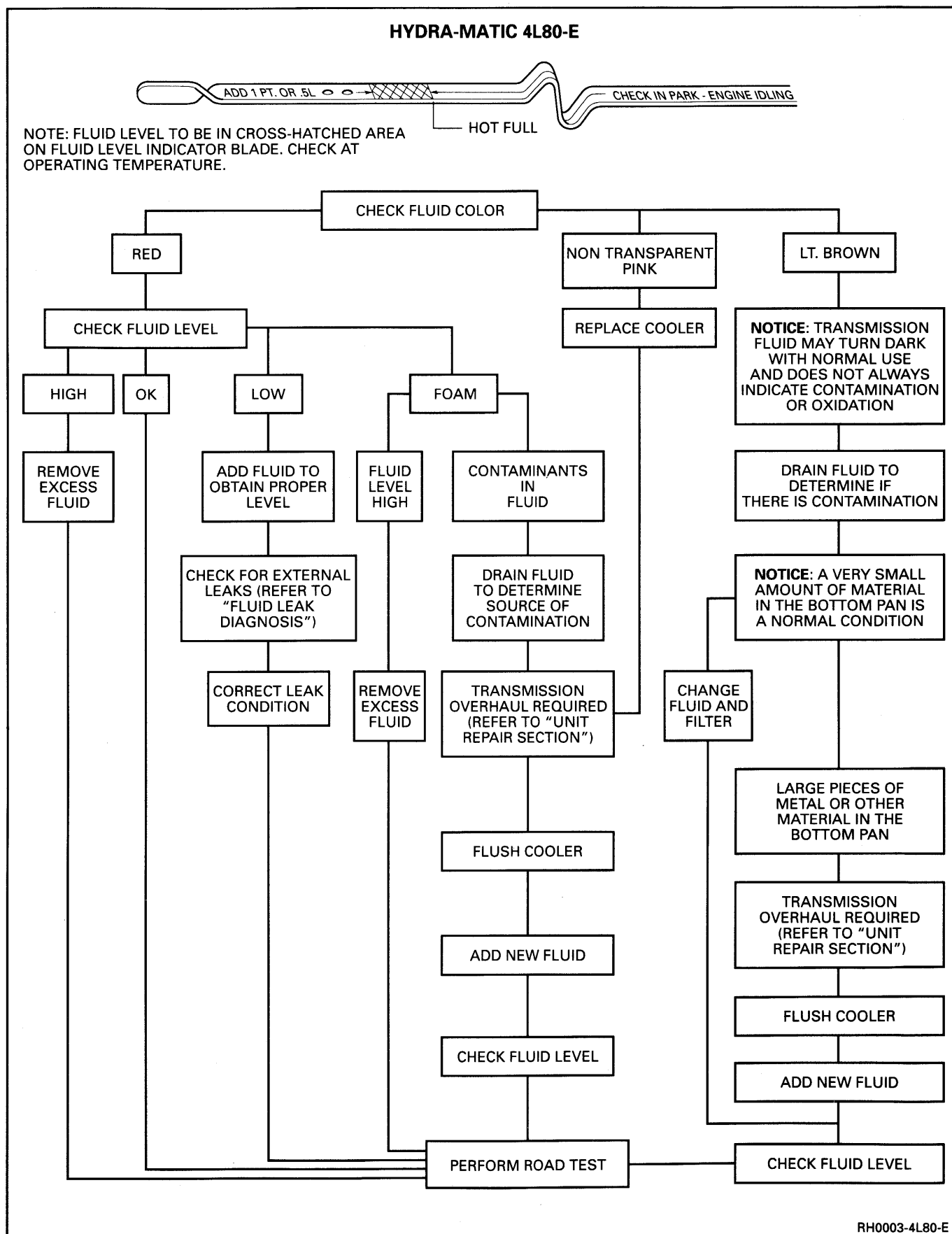


Figure 3 Checking Fluid Color, Level and Condition

HYDRA-MATIC 4L80-E LINE PRESSURE CHECK PRECEDURE

Line pressures are calibrated for two sets of gear ranges – Drive-Park-Neutral, and Reverse. This allows the transmission line pressure to be appropriate for different pressure needs in different gear ranges:

<u>Gear Range</u>	<u>Line Pressure Range</u>
Drive, Park, or Neutral	35 - 171 PSI
Reverse	67 - 324 PSI

Before performing a line pressure check, verify that the pressure control solenoid is receiving the correct electrical signal from the vehicle computer:

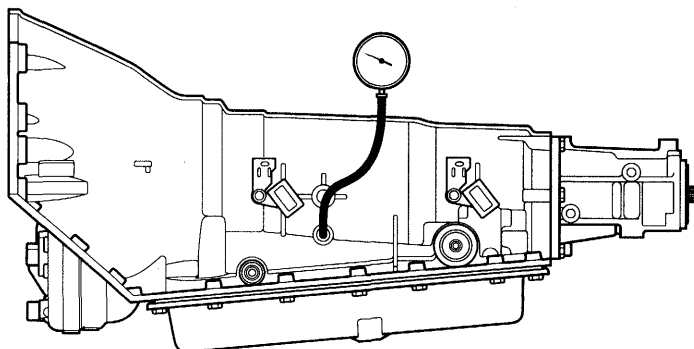
1. Install a scan tool.
2. Start the engine and set parking brake.
3. Check for a stored pressure control solenoid malfunction code, and other malfunction codes.
4. Repair vehicle if necessary.

Inspect:

- Fluid level (see Section 7A)
- Manual linkage

Install or connect

- TECH 1 Scan tool
- Oil pressure gage at line pressure tap



5. Put gear selector in Park and set the parking brake.
6. Start the engine and allow it to warm up at idle.
7. Access the "override pressure control solenoid" test on the TECH 1 scan tool.
8. Increase PRESSURE CONTROL SOLENOID CURRENT in 0.1 Amp. increments and read the corresponding line pressure on the pressure gage. (Allow pressure to stabilize for 5 seconds after each current change.)
9. Compare data to the Drive-Park-Neutral line pressure chart below.

Line pressure will pulse either high or low every ten seconds to keep the pressure control solenoid plunger free. This is normal and will not harm the transmission.

NOTICE:

Total test running time should not exceed 2 minutes, or transmission damage may occur. Increasing the engine speed above idle without vehicle movement (such as holding the brake) in a forward or reverse gear causes transmission stall. Continued operation in the stall condition can result in transmission overheating, malfunction or fluid expulsion.

CAUTION

Brakes must be applied at all times to prevent unexpected vehicle motion.

If pressure readings differ greatly from the line pressure chart, refer to the Diagnosis Charts contained in this section.

The TECH 1 scan tool is only able to control the pressure control solenoid in Park and Neutral with the vehicle stopped at idle. This protects the clutches from extremely high or low pressures in Drive or Reverse ranges.

Pressure Control Solenoid (Amp.)	Line Pressure (PSI)
0.02	157 - 177
0.10	151 - 176
0.20	140 - 172
0.30	137 - 162
0.40	121 - 147
0.50	102 - 131
0.60	88 - 113
0.70	63 - 93
0.80	43 - 73
0.90	37 - 61
0.98	35 - 55

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Figure 4 Line Pressure Check Procedure

1994 HYDRA-MATIC 4L80-E SHIFT SPEED CHART

4.3L ENGINES			1-2 SHIFT +/- 150 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 250 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	WOT 1-2
MODEL	BODY	TPS	10	25	50	10	25	50	10	25	50	0-10	0-10	
ABP, ACP, ADP, AFP, AHP	C, K P G	TRANS RPM	560	720	1100	1030	1340	1950	1700	1825	2630	610	390	1530

5.7L ENGINES			1-2 SHIFT +/- 150 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 250 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	WOT 1-2
MODEL	BODY	TPS	10	25	50	10	25	50	10	25	50	0-10	0-10	
BJP, BMP, BNP, JHP, MBP, MCP, MRP, MTP	C, K G, P ISUZU	TRANS RPM	520	775	1020	940	1380	1810	1490	1940	2600	740	420	1580

6.5L ENGINES			1-2 SHIFT +/- 150 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 250 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	WOT 1-2
MODEL	BODY	TPS	10	25	50	10	25	50	10	25	50	0-10	0-10	
LAP, LBP, LFP, LHP, LLP, LUP	G, P C, K	TRANS RPM	350	465	860	700	880	1510	1280	1345	2160	650	325	1260
LUP	DERATED P	TRANS RPM	360	385	720	700	730	1280	1040	1095	1780	620	280	920

7.4L ENGINES			1-2 SHIFT +/- 150 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 250 RPM			3-2 +/- 100 RPM	2-1 +/- 100 RPM	WOT 1-2
MODEL	BODY	TPS	10	25	50	10	25	50	10	25	50	0-10	0-10	
DLP, DNP, DPP, DRP, MSP, TWP, TXP	C, G, K, P	TRANS RPM	480	760	1070	990	1455	1930	1600	2055	2740	740	420	1530

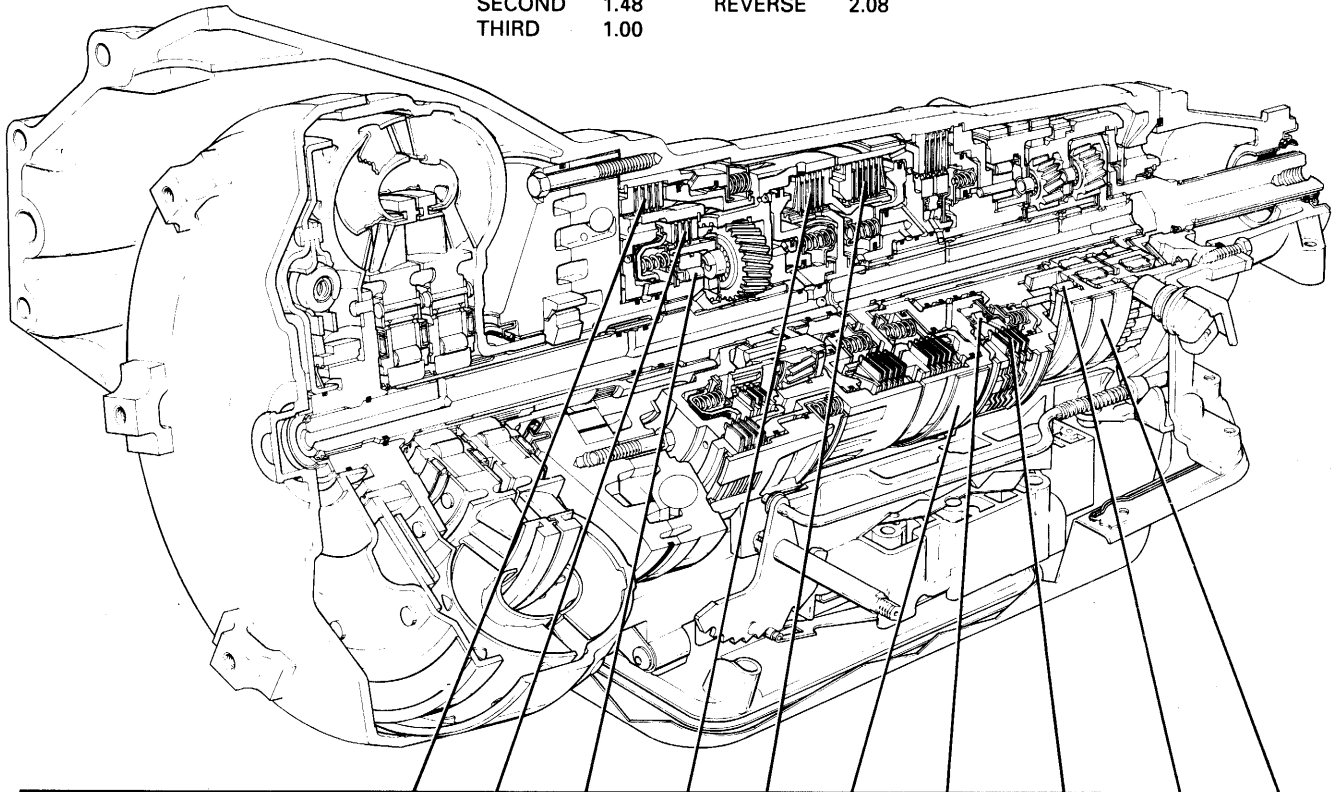
- NOTES: 1. ALL SPEEDS GIVEN ARE IN TRANSMISSION OUTPUT SHAFT RPM.
 2. SPEEDS ARE BASED ON PERCENT THROTTLE POSITION (TPS) DATA.
 3. USE A TECH 1® OR OTHER SCAN TOOL TO MONITOR THIS DATA.
 4. N/V (MPH) = O.S. RPM.

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Figure 5 Shift Speed Chart

HYDRAMATIC 4L80-E - GEAR RATIOS

FIRST	2.48	FOURTH	.75
SECOND	1.48	REVERSE	2.08
THIRD	1.00		



RANGE	GEAR	SOLENOID @A	SOLENOID @B	FOURTH CLUTCH	OVERRUN CLUTCH	OVERDRIVE ROLLER CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	FRONT BAND	INTERMEDIATE SPRAG CLUTCH	INTERMEDIATE CLUTCH	LO ROLLER CLUTCH	REAR BAND
P-N		ON	OFF			HOLDING							
R	REVERSE	ON	OFF			HOLDING		APPLIED					APPLIED
D	1st	ON	OFF			HOLDING	APPLIED			*		HOLDING	
	2nd	OFF	OFF			HOLDING	APPLIED			HOLDING	APPLIED	OVERRUNNING	
	3rd	OFF	ON			HOLDING	APPLIED	APPLIED		OVERRUNNING	APPLIED	OVERRUNNING	
	4th	ON	ON	APPLIED		OVERRUNNING	APPLIED	APPLIED		OVERRUNNING	APPLIED	OVERRUNNING	
D	1st	ON	OFF		APPLIED	HOLDING	APPLIED			*		HOLDING	
	2nd	OFF	OFF		APPLIED	HOLDING	APPLIED			HOLDING	APPLIED	OVERRUNNING	
	3rd	OFF	ON		APPLIED	HOLDING	APPLIED	APPLIED		OVERRUNNING	APPLIED	OVERRUNNING	
2	1st	ON	OFF		APPLIED	HOLDING	APPLIED			*		HOLDING	
	2nd	OFF	OFF		APPLIED	HOLDING	APPLIED		APPLIED	HOLDING	APPLIED	OVERRUNNING	
1	1st	ON	OFF		APPLIED	HOLDING	APPLIED			*		HOLDING	APPLIED
	2nd	OFF	OFF		APPLIED	HOLDING	APPLIED		APPLIED	HOLDING	APPLIED	OVERRUNNING	

*HOLDING BUT NOT EFFECTIVE

@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED AND THROTTLE POSITION. IT DOES NOT DEPEND UPON THE SELECTED GEAR.

ON = SOLENOID ENERGIZED

OFF = SOLENOID DE-ENERGIZED

NOTE: DESCRIPTIONS ABOVE EXPLAIN COMPONENT FUNCTION DURING ACCELERATION.

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Figure 6 Clutch Application Chart

TORQUE CONVERTER CLUTCH (TCC)

DIAGNOSIS

The Torque Converter Clutch is applied by fluid pressure which is controlled by a pulse width modulated (PWM) solenoid located inside the Automatic Transmission assembly. The solenoid is energized by completing an electrical circuit through a combination of switches and sensors.

Functional Check Procedure

Figure 12



Inspect

1. Install a tachometer or scan tool.
2. Drive the vehicle until proper transmission operating temperature is reached.
3. Drive the vehicle at 80 to 88 km/h (50 to 55 mph) with light throttle.
4. Maintaining throttle, lightly touch the brake pedal and check for release of the TCC and a slight increase in engine RPM.
5. Release the brake, slowly accelerate and check for a re-apply of the TCC and a slight decrease in engine rpm.

To properly diagnose the Torque Converter Clutch (TCC) system, perform all electrical testing first and then test the hydraulic system.

- For diagnosis of electrical or emission control related components of the TCC, refer to the Driveability, Emission, and Electrical Diagnosis Manual.
- Additional TCC diagnosis information is available in the "Wiring Diagram, Diagnosis Charts, Malfunction Diagnostic Trouble Code (DTC) Diagnosis, and Malfunction Diagnostic Trouble Code (DTC) Actions" contained in this section.
- For diagnosis of TCC hydraulic controls, refer to the "Fluid Flow and Circuit Descriptions" provided in this section.

NOTICE: Use only high impedance type ohmmeters for electrical testing on the TCC circuit. If another type of meter is used, false readings and damage to the circuits may occur.

NOTICE: PWM solenoid is different than other TCC solenoids, it runs on 32 hertz and is not an on-off switch.

TORQUE CONVERTER EVALUATION

The torque converter should be replaced under any of the following conditions.

- External leaks in the hub weld area.
- Converter hub is scored or damaged.
- Converter pilot is broken, damaged or fits poorly into crankshaft.
- Steel particles are found after flushing the cooler and cooler lines.

- Pump is damaged or steel particles are found in the converter.
- Vehicle has TCC shudder and/or no TCC apply. Replace only after all hydraulic and electrical diagnosis has been made. (Converter clutch material may be glazed.) See "TCC Shudder Diagnosis" later in this section.
- Converter has an imbalance which cannot be corrected. (Refer to Converter Vibration Test Procedure in the Transmission Unit Repair Section.)
- Converter is contaminated with engine coolant containing antifreeze.
- Internal failure of stator roller clutch.
- Excess end play.
- Heavy clutch debris due to overheating (blue converter).
- Steel particles or clutch lining material found in fluid filter or on magnet when no internal parts in unit are worn or damaged – indicates that lining material came from converter.

Noise

Torque converter whine is usually noticed when the vehicle is stopped and the transmission is in "Drive" or "Reverse." The noise will increase when engine rpm is increased. The noise will stop when the vehicle is moving or when the torque converter clutch is applied because both halves of the converter are turning at the same speed.

Perform a stall test to make sure the noise is actually coming from the converter.

1. Place foot on brake.
2. Put gear selector in "Drive."
3. Depress accelerator to approximately 1200 rpm for no more than six seconds.

NOTICE: If the accelerator is depressed for more than six seconds, damage to the transmission may occur.



Important

- This noise should not be confused with pump whine noise which is usually noticeable in "Park," "Neutral" and all other gear ranges. Pump whine will vary with pressure ranges.

Torque Converter Stator

The torque converter stator roller clutch can malfunction in two different ways. It can either remain locked up at all times or freewheel in both directions.

If the stator is freewheeling at all times, the vehicle tends to have poor acceleration from the standstill. The car may act normal at speeds above 50 to 55 km/h (30 to 35 mph). If poor acceleration is noted, it should first be determined that the exhaust system is not blocked, the engine timing is correct, and the transmission is in first gear when starting out.

If the engine accelerated freely to high RPM in "Neutral" (N), it can be assumed that the engine and exhaust system are normal. Checking for poor performance in "Drive" (D) and "Reverse" (R) will help determine if the stator is freewheeling at all times.

If the stator is locked up at all times, performance from a standstill appears normal, however, engine rpm and acceleration is restricted or limited at high speeds. The engine may overheat with this condition. Visual examination of the converter may reveal a blue color from overheating.

If the torque converter has been removed from the vehicle, the stator roller clutch can be checked by inserting a finger into the splined inner race of the roller clutch and trying to turn the race in both directions. The inner race should turn freely clockwise, but not turn or be very difficult to turn counter-clockwise.

The Torque Converter Should Not Be Replaced If:

- The oil has an odor, is discolored, and there is no evidence of metal or clutch facing particles.
- The threads in one or more of the converter bolt holes are damaged.
 - Correct with thread insert. (Refer to Section 6A).
- Transmission failure did not display evidence of damage or worn internal parts, steel particles or clutch plate lining material in unit and inside the fluid filter.
- Vehicle has been exposed to high mileage (only). The exception may be where the torque converter clutch dampener plate lining has seen excess wear by vehicles operated in heavy and/or constant traffic, such as taxi, delivery or police use.

TCC SHUDDER DIAGNOSIS

The key to diagnosing TCC shudder is to note when it happens and under what conditions.

TCC shudder should only occur during the APPLY and/or RELEASE of the converter clutch – NEVER after the TCC plate is fully applied.

While TCC is Applying or Releasing

If the shudder occurs while the TCC is applying, the problem is within the transmission or torque converter. Something is not allowing the clutch to become fully engaged, not allowing clutch to release, or is trying to release and apply the clutch at the same time. This could be caused by leaking turbine shaft seals, a restricted release orifice, a distorted clutch, a damaged torque converter housing surface due to long converter bolts, or defective friction material.

After TCC Has Applied

If shudder occurs after the TCC has applied (often with engine under load such as climbing a hill), most

of the time there is nothing wrong with the transmission! As mentioned above, once the TCC has been applied, it is very unlikely that it will slip. Engine problems that may go unnoticed under light throttle and load become noticeable when going up a hill, or when accelerating, due to the mechanical lock-up between engine and transmission.

REMEMBER: Once TCC is applied, there is no torque converter (fluid coupling) assistance. Engine or driveline vibrations could be unnoticeable before TCC engagement.

The following components should be inspected to avoid misdiagnosis of TCC Shudder and possibly disassembling a transmission and/or replacing a converter unnecessarily.

- Spark plugs – Inspect for cracks, high resistance or broken insulator.
- Plug wires – Look in each end. If there is red dust (ozone) or black substance (carbon) present, then the wires are bad. Also look for a white discoloration of the wire indicating arcing during hard acceleration.
- Distributor cap and rotor – Look for broken or uncrimped parts.
- Coil – Look for black on bottom indicating arcing while engine is misfiring.
- Fuel injector – Filter may be plugged.
- Vacuum leak – Engine won't get correct amount of fuel. May run rich or lean depending on where the leak is.
- EGR valve – Valve may let in too much unburnable exhaust gas and cause engine to run lean.
- MAP/MAF sensor – Like vacuum leak, engine won't get correct amount of fuel for proper engine operation.
- Carbon on intake valve – Restricts proper flow of air/fuel mixture into cylinders.
- Flat cam – Valves don't open enough to let proper fuel/air mixture into cylinders.
- Oxygen sensor – May command engine too rich or too lean for too long.
- Fuel pressure – May be too low.
- Engine Mounts – Vibration of mounts can be multiplied by TCC engagement.
- Axle joints – Check for vibration.
- TP Sensor – TCC apply and release depends on TP Sensor in many engines. If TP Sensor is out of specification, TCC may remain applied during initial engine crowd.
- Cylinder balance – Bad piston rings or poorly sealed valves can cause low power in a cylinder.
- Fuel contamination – Causes poor engine performance.

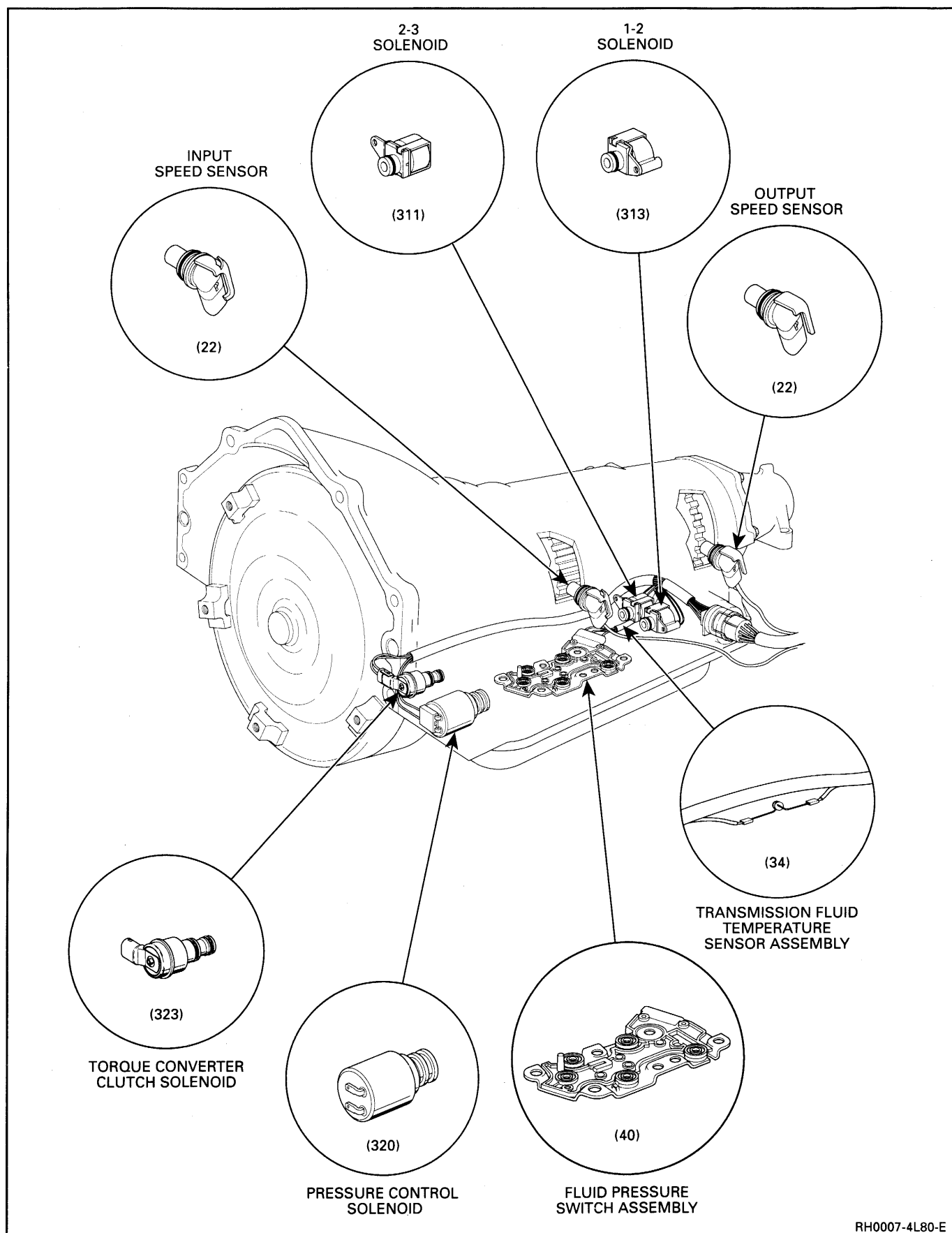


Figure 7 Electronic Component Location Views

TORQUE CONVERTER CLUTCH (TCC) SOLENOID

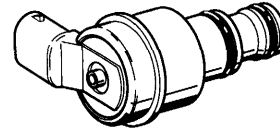
The Torque Converter Clutch (TCC) solenoid is located on the transmission valve body and is energized by the PCM/TCM. The TCC solenoid acts on the TCC apply valve to control torque converter clutch application.

The TCC solenoid is pulse width modulated by the PCM/TCM. This means that the PCM/TCM pulses the solenoid so that the hydraulic pressure against the torque converter clutch modulates. This modulated pressure allows the TCC to slip slightly thus keeping the TCC balanced just at the point of engagement.

There are two diagnostic codes associated with the TCC solenoid. The first code is Code 83 (quad driver fault). Code 83 is designed to detect a fault in the TCC circuit.

While Code 83 is set, both 4th gear and TCC are inhibited. Recovery can occur on the next ignition cycle.

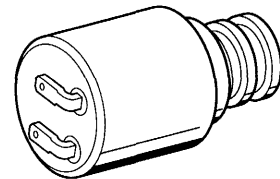
Other Possible default codes: 39, 68, 69.



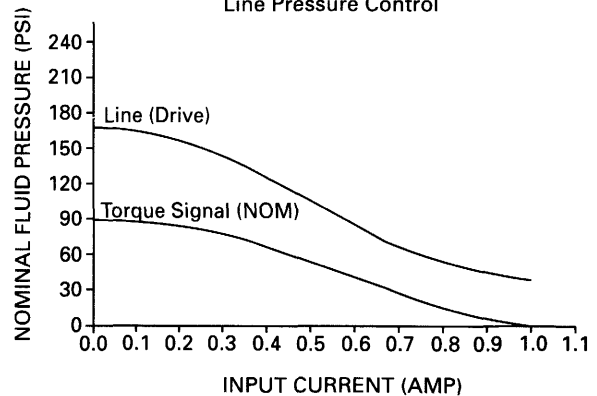
PRESSURE CONTROL SOLENOID

The pressure control solenoid is attached to the valve body and controls line pressure by moving a pressure regulator valve against spring pressure. The pressure control solenoid takes the place of the throttle valve or vacuum modulator used on past model transmissions. The PCM/TCM varies line pressure based on engine load. Engine load is calculated from various inputs especially the TP Sensor switch. Line pressure is actually varied by changing the amperage applied to the pressure control solenoid from 0 (high pressure) to 1.1 amps (low pressure). The pressure control solenoid current is periodically pulsed to prevent contamination from sticking the pressure regulator valve.

There is one diagnostic code associated with the pressure control solenoid, Code 73. Code 73 will set when the PCM/TCM detects a difference of .16 amp or more between the amperage commanded and actual amperage. While the code is set, the pressure control solenoid will be turned "OFF." Recovery can occur after the next ignition cycle. Code 73 will not sense a hydraulic problem such as a stuck valve.



Pressure Control Solenoid
Line Pressure Control

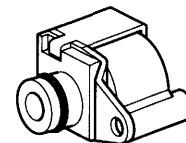


1-2 SOLENOID

1-2 solenoid is attached to the valve body and is a normally open exhaust valve. The PCM/TCM activates the solenoid by grounding it through an internal quad driver. 1-2 solenoid is "ON" in 1st and 4th gear, but "OFF" in 2nd and 3rd gears. When "ON," the solenoid redirects fluid to act on the shift valves. 1-2 solenoid is usually blue in color.

There is one diagnostic code associated with 1-2 solenoid, Code 82 (QDM and 1-2 solenoid fault). The PCM/TCM continually monitors the 1-2 solenoid circuit for expected voltage ("OFF" high, "ON" low). If the voltage reading is not what is expected on the circuit, Code 82 will be set. Should the fault disappear, recovery will occur on the next ignition cycle.

Other Possible default codes: 68.



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Figure 8 Electronic Component Descriptions

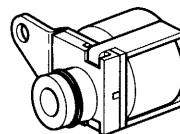
2-3 SOLENOID

2-3 solenoid is attached to the valve body and is a normally open exhaust valve. The PCM/TCM activates the solenoid by grounding it through an internal quad driver. 2-3 solenoid is "ON" in 3rd and 4th gear and "OFF" in 1st and 2nd gear. When "ON," the solenoid redirects fluid to act on the shift valves.

2-3 solenoid has three diagnostic codes associated with it. The first code is Code 81 (QDM and 2-3 solenoid fault). The PCM/TCM continually monitors the 2-3 solenoid circuit for expected voltage ("OFF" high, "ON" low). If the voltage reading is not what is expected, Code 81 will set. While Code 81 is present, TCC operation will be inhibited, line pressure will be set to maximum and the transmission will not shift past 2nd gear. Recovery can occur at the next ignition cycle.

The second code is Code 87 (shift circuit "B" stuck "OFF"). Code 87 will set when the calculated gear ratio is numerically higher than the gear commanded (must be 3rd or 4th gear). No default actions are taken.

The final code is Code 86 (high ratio). Code 86 is set when the PCM/TCM detects 1st or 2nd gear at high speed. No default actions are taken.



FLUID PRESSURE SWITCH ASSEMBLY

A gear range sensing device called a Transmission Fluid Pressure Switch Assembly is used by the PCM/TCM to sense what gear range has been selected by the vehicle operator. The Transmission Fluid Pressure Switch Assembly is located on the valve body and consists of five pressure switches combined into one unit. The PCM/TCM applies system voltage to the Transmission Fluid Pressure Switch Assembly or three separate wires. These three circuits are either grounded or open, depending on which gear range has been selected and what combination of the five switches have pressure applied to them.

When the vehicle is in "PARK" with the key "ON," engine "OFF," the normal state of the Transmission Fluid Pressure Switch Assembly will be "DRIVE 2". When the key is "ON" and the engine is running, the normal state of the Transmission Fluid Pressure Switch Assembly will be "PARK/NEUTRAL."

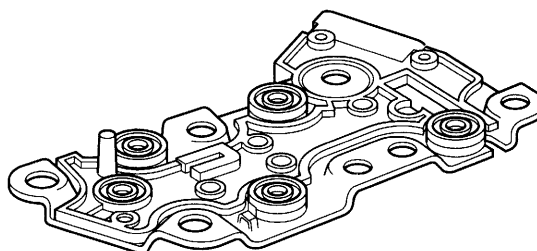
There are two possible combinations of the switches within the pressure switch manifold that do not represent an actual gear range. If either of these combinations are detected by the PCM/TCM for .5 seconds or longer, Code 28 will set. Code 28 will not set, however, if a valid gear range combination appears at the wrong time.

While Code 28 is present, the PCM/TCM will take the following actions:

1. Assume drive 4 for shift pattern control.
2. Use drive 2 pressure table.
3. Inhibit 4th gear operation.
4. Inhibit TCC operation.

If the Transmission Fluid Pressure Switch Assembly resumes normal functioning, the transmission will resume normal operation after the next ignition cycle.

Other Possible default codes: 68.

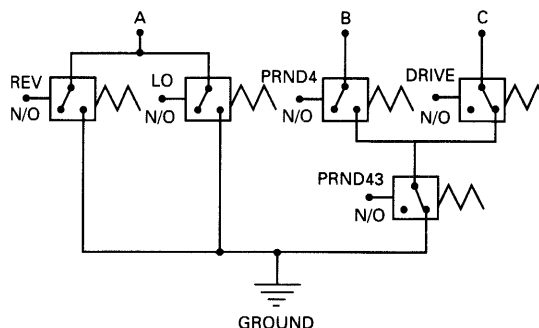


Range Indicator	Fluids					Circuit		
	Rev	Lo	PRND4	PRND43	Drive	A	B	C
Park						1	0	1
Reverse						0	0	1
Neutral						1	0	1
(D)						1	0	0
D						1	1	0
2						1	1	1
1						0	1	1

■ - Pressurized

0 - Grounded: 0V LOW

1 - Open: 12V HIGH



RH0009-4L80-E

Figure 9 Electronic Component Descriptions

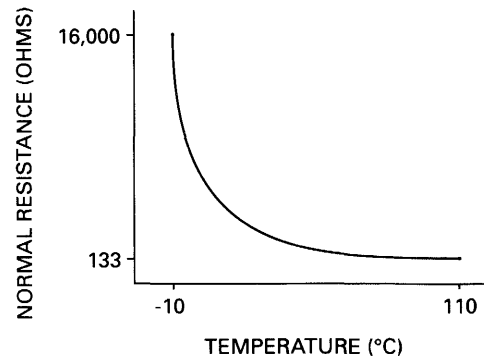
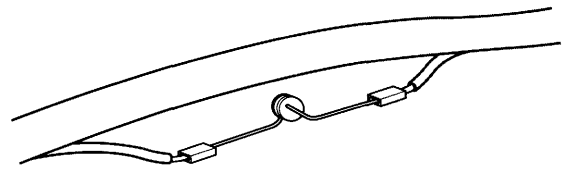
TRANSMISSION FLUID TEMPERATURE SENSOR ASSEMBLY

The Transmission Fluid Temperature Sensor Assembly is a thermistor (a resistor that changes value based on temperature) mounted in the wiring harness assembly. Low transmission temperature produces high resistance while high temperature produces low resistance. The PCM/TCM supplies a 5 volt signal to the Transmission Fluid Temperature Sensor Assembly through an internal resistor then measures the voltage drop in the circuit. Voltage will be high when the transmission is cold and low when the transmission is hot.

The PCM/TCM uses the Transmission Fluid Temperature Sensor Assembly to regulate torque converter clutch apply, as well as shift quality.

Code 58 and 59 indicate a fault in the Transmission Fluid Temperature Sensor Assembly circuit. Most "Scan" tools will display transmission temperature in degrees celsius. After the vehicle has been started, transmission temperature should rise steadily and stabilize between 90° and 115° celsius depending on load. Both codes will cause the PCM/TCM to use a default value of 131° celsius thus reacting as if the transmission were hot in either case. When Code 58 or 59 are set, the Torque Converter Clutch (TCC) is enabled in second, third and fourth and will apply early. Some driveability symptoms will be noticed, especially when cold.

Other Possible default codes: 79.



TRANSMISSION INPUT / OUTPUT SPEED SENSOR ASSEMBLY

Both the input and output speed sensors are of the magnetic induction type. The input and output sensors are accessible from the left hand side of the transmission. The input speed sensor just forward of center and the output speed sensor near the rear. A voltage signal is induced in the input speed sensor by serrations cut in the outside diameter of the forward clutch housing. Voltage is induced in the output sensor by gear teeth pressed on the outside diameter of the rear carrier assembly. The output sensor may be thought of as replacing the governor. Also note that output speed may differ from speedometer readings because the output speed sensor reading is not corrected for minor variations in axle ratio or tire size.

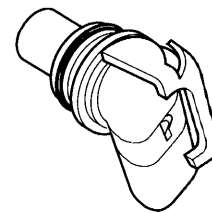
The PCM/TCM uses speed information from these sensors to determine the following:

- Engine is running.
- Vehicle speed.
- Calculate gear ratio.
- Calculate TCC slip.
- Calculate turbine speed.

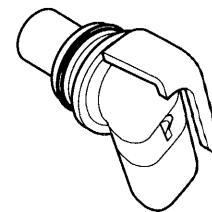
If the input speed sensor is not operational at start up and reads 0, this will cause the output sensor to also read 0. There is no direct code associated with an input sensor fault, however, an inaccurate input sensor could cause other codes to set especially those associated with ratios or slip.

Code 24 will set if a fault exists in the output sensor circuit and a default value will be substituted by the PCM/TCM. As long as the fault remains and the code is set, the PCM/TCM will only allow 4-3, 3-2 and 1-2 shifts to occur. If the fault is removed, normal operation will resume after the next ignition cycle.

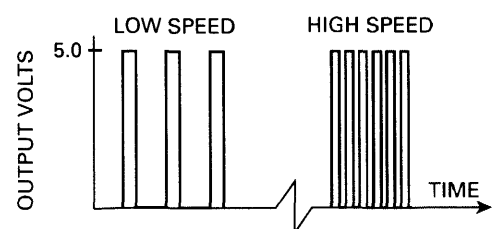
Other Possible default codes: 72, 74.



INPUT SPEED SENSOR



OUTPUT SPEED SENSOR



CONDITIONED SIGNAL

RH0010-4L80-E

Figure 10 Electronic Component Descriptions

TRANSMISSION ELECTRICAL CONNECTOR

The transmission electrical connector is a very important part of the HYDRA-MATIC 4L80-E operating system. Anything that interferes with the electrical connection can cause the transmission to set Diagnostic Trouble Codes and/or operate incorrectly.

The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped (in either the transmission or vehicle wiring harness)
- Dirt contamination entering the connector when it is unconnected
- Pins in the connector backing out of the connector or pushed out during connection
- Excessive transmission fluid leaking into the connector, wicking up into the vehicle wiring harness and degrading the wire insulation *
- Water/moisture intrusion in the connector
- Low pin retention from excessive connection and disconnection of the wiring harness
- Pin corrosion from contamination

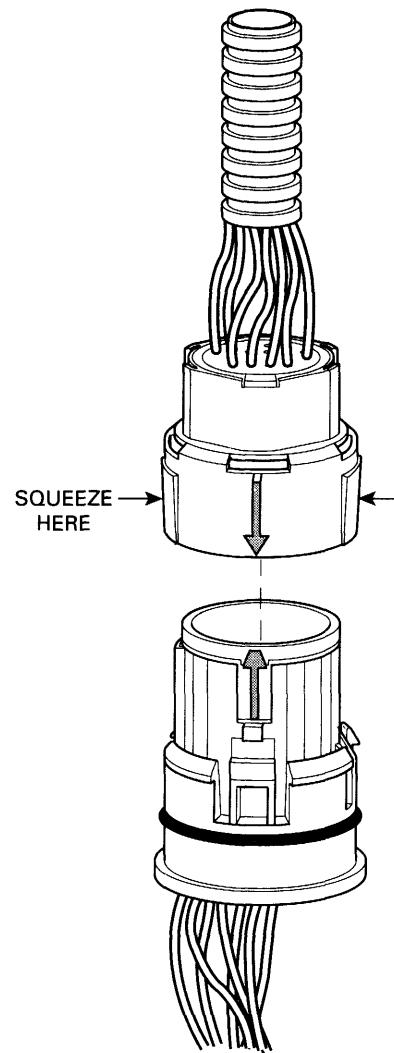
* The presence of transmission fluid in the transmission connector is not harmful in itself. The fluid only affects the vehicle harness wiring insulation if the fluid wicks up that far.

Points to remember when working with the transmission electrical connector:

- To remove the connector, squeeze the two tabs towards each other and pull straight up (See illustration).
- Carefully limit twisting or wiggling the connector during removal. This can bend pins.
- DO NOT pry the connector off with a screwdriver or other tool.
- To install the connector, first orient the pins by lining up the arrows on each half of the connector. Push the connector straight down into the transmission without twisting or angling the mating parts.
- The connector should click into place with a positive feel and/or noise.
- Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple Diagnostic Trouble Codes will set. Be sure to clear these codes after re-connecting the pass-thru connector.

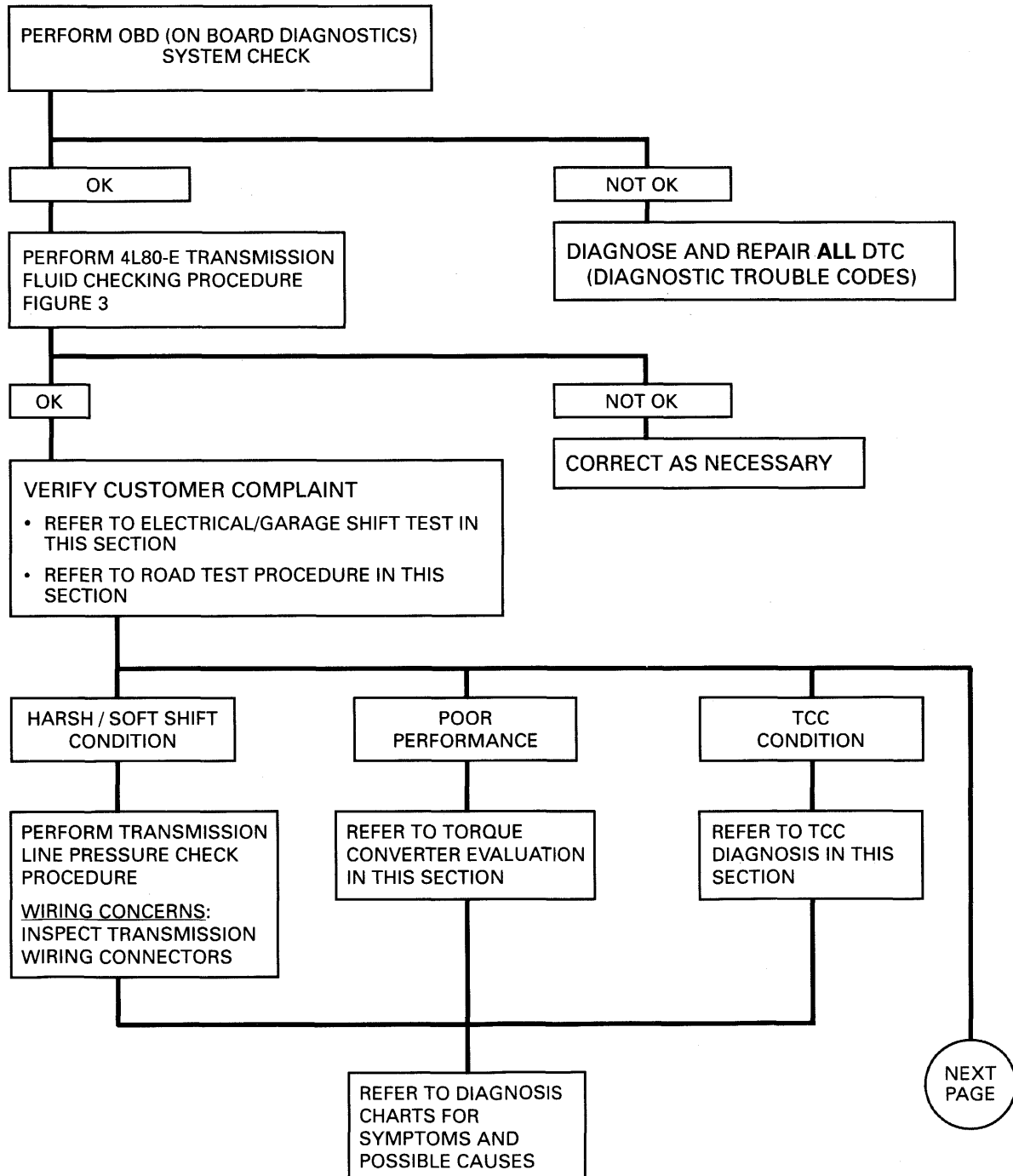
DTC's 59, 81 and 82 will set with key on, engine off.

DTC's 59, 73, 81 and 82 will set with key on, engine on.



RH0011-4L80-E

Figure 11 Transmission Electrical Connector

**4L80-E TRANSMISSION
FUNCTIONAL TEST (1 of 2)**

RH0012-4L80-E

Figure 12 Transmission Functional Test (1 of 2)

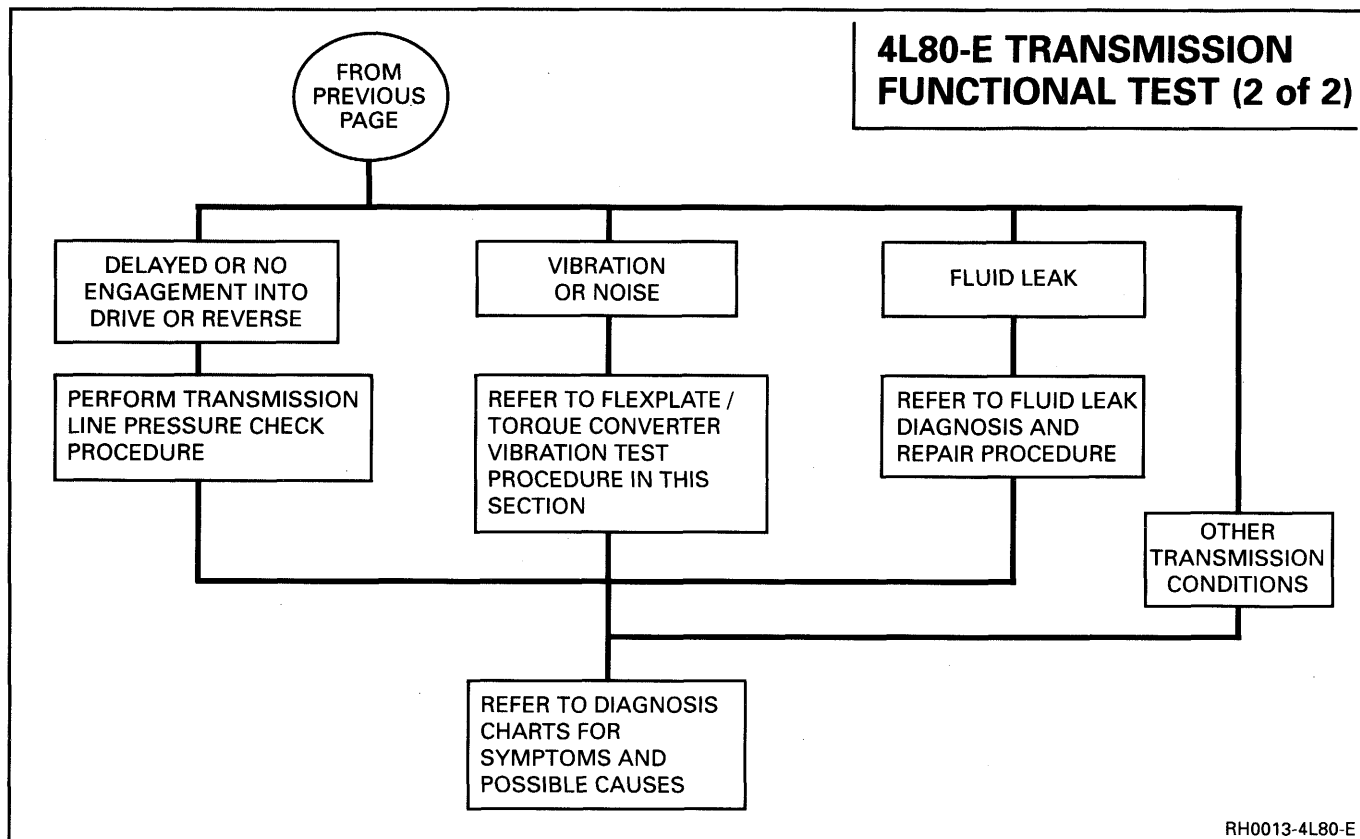


Figure 13 Transmission Functional Test (2 of 2)

MALFUNCTION CODE DIAGNOSIS AND DEFAULT ACTION

Refer to the Diagnosis Trouble Tree Charts in Section 10 and 10B of Driveability and Emissions Manual.

CODE AND CIRCUIT	PROBABLE CAUSE	DEFAULT ACTION
14 Engine Temperature High	Signal voltage has been above 151°C (304°F) for 1 second.	• TCC apply cold. • Loss of driveability.
15 Engine Temperature Low	Signal voltage has been less than -37°C (-34°F) for 1 second.	• TCC apply cold. • Loss of driveability.
21** Throttle Position High	Code 21 will set if signal voltage has been above 4.9 volts for 1 second.	• Set line pressure to maximum. • Fixed shift points. • Inhibit 4th gear / No 4th gear. • Inhibit TCC operation.
21** Accelerator Pedal Position (APP) 1 Circuit High	Code 21 will set if voltage is greater than 4.75 volts for 2 seconds on APP 1 sensor.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
22** Throttle Position Low	Code 22 will set if TPS signal voltage is below 0.2 volt for more than 1 second.	• Set pressure to maximum. • Fixed shift points. • Inhibit 4th gear / No 4th gear. • Inhibit TCC operation.
22** Accelerator Pedal Position (APP) 1 Circuit Low	Code 22 will set if voltage is less than 0.25 volts for 2 seconds on APP 1 sensor.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
23** Accelerator Pedal Position (APP) 1 Circuit Range Fault	Code 23 will set when the PCM compares all APP sensors and determines if there is a 6% difference between APP 1 and APP 2 and a 10% difference to APP 3.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
24 Vehicle Speed Sensor	With input speed at least 3000 rpm, output speed must read less than 200 rpm for 1.5 seconds.	• Set pressure to maximum. • Allow 4-3, 3-2, and 1-2 shifts, then maintain 2nd gear. • Calculate output speed from input speed. • 2nd gear only.
25** Accelerator Pedal Position (APP) 2 Circuit High	Code 25 will set when Voltage is greater than 4.75 volts for 2 seconds on APP 2 sensor.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
26** Accelerator Pedal Position (APP) 2 Circuit Low	Code 26 will set when Voltage is less than 0.25 volts for 2 seconds on APP 1 sensor.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
27** Accelerator Pedal Position (APP) 2 Circuit Range Fault	Code 27 will set when the PCM compares all APP sensors and determines if there is a 6% difference between APP 1 and APP 2 and a 10% difference to APP 3.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

RH0014-4L80-E

Figure 14 Malfunction Diagnostic Trouble Code (DTC) Diagnosis Chart A

MALFUNCTION CODE DIAGNOSIS AND DEFAULT ACTION

Refer to the Diagnosis Trouble Tree Charts in Section 10 and 10B of Driveability and Emissions Manual.

CODE AND CIRCUIT	PROBABLE CAUSE	DEFAULT ACTION
28 Automatic Transmission Fluid Pressure Switch Asm.	PCM/TCM must see one of two "illegal" combinations from the Automatic Transmission Fluid Pressure Switch Asm.	- Assume (D) Drive 4 is selected. - Inhibit 4th gear operation. - Inhibit TCC operation.
31** Baro Sensor Circuit Low	Code 31 will set when Actual BARO pressure is less than 15 kPa for 2 seconds.	Fixed BARO value.
33** Baro Sensor Circuit High	Code 33 will set when BARO is greater than 105 kPa for 2 seconds.	Fixed BARO value.
37 Brake Switch Stuck "ON"	With brake on, vehicle speed is 5-20 mph for six seconds, then vehicle speed is > 20 mph for six seconds. After vehicle speed is < 5 mph. This must happen seven times.	- No TCC. - No fourth gear in hot mode.
38 Brake Switch Stuck "OFF"	With brake off, vehicle speed is > 20 mph for six seconds, then vehicle speed is 5-20 mph for six seconds. After vehicle speed is < 5 mph. This must happen seven times.	- No TCC. - No fourth gear in hot mode.
39 TCC Stuck "OFF"	Code 39 sets if the TCC slip is greater than 65 rpm for 2 seconds or when TCC is locked and 2nd and 3rd gears are indicated.	No default action
51 Prom Error	Code 51 sets when the PROM checksum is bad.	No default action.
52 System Voltage High Long	Code 52 will set if system voltage is above 16 volts for 109 minutes.	- Maximum line pressure. 2nd gear only. - Inhibit TCC operation.
53 System Voltage High	Code 53 will set if system voltage is above 19.5 volts for 2 minutes.	- Maximum line pressure. 2nd gear only. - Inhibit TCC operation.
58 Transmission Temperature High	Transmission temperature must be above 151°C (-34°F) for 1 second.	- TCC in 2nd, 3rd and 4th gears. - Maximum line pressure.
59 Transmission Temperature Low	Transmission temperature must be below -37°C (-34°F) for 1 second.	- TCC in 2nd, 3rd and 4th gears. - Maximum line pressure.
63** Accelerator Pedal Position (APP) 3 Circuit High	Code 63 will set when voltage is greater than 4.75 volts for 2 seconds on APP 3 sensor.	"Service Throttle Soon" lamp on. - PCM will limit power. - Engine will operate at idle only.
63† Baro Sensor Circuit High	Code 63 will set when BARO sensor signal voltage is greater than 4.9 volts for longer than 2 seconds.	No altitude compensation of shift patterns.

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

RH0015-4L80-E

Figure 15 Malfunction Diagnostic Trouble Code (DTC) Diagnosis Chart B

MALFUNCTION CODE DIAGNOSIS AND DEFAULT ACTION

Refer to the Diagnosis Trouble Tree Charts in Section 10 and 10B of Driveability and Emissions Manual.

CODE AND CIRCUIT	PROBABLE CAUSE	DEFAULT ACTION
64** Accelerator Pedal Position (APP) 3 Circuit Low	Code 64 will set when voltage is less than 0.25 volts for 2 seconds on APP 3 sensor.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
64† Baro Sensor Circuit Low	Code 64 will set when BARO sensor signal voltage is less than 1.9 volts for longer than 2 seconds.	• No altitude compensation of shift patterns.
65** Accelerator Pedal Position (APP) 3 Circuit Range Fault	Code 65 will set when the PCM compares all APP sensors and determines if there is a 6% difference between APP 1 and APP 2 and a 10% difference to APP 3.	• "Service Throttle Soon" lamp on. • PCM will limit power. • Engine will operate at idle only.
68 Transmission Component Slipping	Code 68 will set if the engine speed is 200 rpm higher than input speed for 2 seconds must be in 4th gear TCC engaged. Slipping clutches, refer to three column Diagnosis Charts for "No TCC" & "No Fourth Gear".	• Set pressure to maximum. • Inhibit 4th gear. • No TCC. • PCM defaults to read.
69 Torque Converter Clutch (TCC) Stuck "On"	Code 69 will set when no codes 21, 22, 28, 71 or 74 are set. TCC slip speed indicates between - 5 and +10. TCC solenoid is commanded "OFF". TP sensor signal is greater than 25%. Trans range switch indicates D3 or D4. Commanded gear indicates 2nd or 3rd gear. All conditions are met for 2 seconds.	• No default action.
71‡ Camshaft Position Sensor Circuit Low	Code 71 will set when no code 28 is set. Engine speed is less than 50 rpm. Trans range indicates R, D4, D3 or D1. All conditions are met for 2 seconds.	• Inhibit TCC operation.
72 Vehicle Speed Sensor (VSS) Circuit Loss (Trans Output Speed Signal)	Code 72 will set when not in Park or Neutral, Trans output speed change is > 1000 rpm. No code 28 set. When in Park or Neutral, Trans output speed change is > 2050 rpm. Engine speed is > 300 rpm. All conditions are met for 2 seconds.	• A (soft) delayed landing to second gear and second gear starts. • Line pressure increases to max.
73 Pressure Control Solenoid Current	Code 73 sets when actual pressure control solenoid current is more than 0.16 Amps lower than command current.	• Maximum line pressure.
74**‡ Transmission Input Speed (TIS) Sensor Circuit	Code 74 will set when no codes 24, 28 or 71 are set. Trans not in Park or Neutral. Engine speed > 300 rpm. Trans output speed > 200 rpm. Trans input speed < 50 rpm. All conditions are met for 2 seconds.	• Inhibit TCC operation.

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

RH0016-4L80-E

Figure 16 Malfunction Diagnostic Trouble Code (DTC) Diagnosis Chart C

MALFUNCTION CODE DIAGNOSIS AND DEFAULT ACTION

Refer to the Diagnosis Trouble Tree Charts in Section 10 and 10B of Driveability and Emissions Manual.

CODE AND CIRCUIT	PROBABLE CAUSE	DEFAULT ACTION
75 System Voltage Low	Code 75 will set when system voltage falls below 6.7 volts at -40°C (-40°F) and/or higher than 10.5 volts at 150°C (302°F).	• Turn pressure control solenoid "OFF". • Allow 4-3, 3-2, and 1-2 shifts, then maintain 2nd gear. • Inhibit TCC and 4th gear. • 2nd gear only.
79 Transmission Fluid Overtemp	Code 79 will set when no code 58. Trans fluid temp is greater than 145°C (261°F). All conditions met for 30 minutes.	• No default action.
81 2-3 Shift Solenoid Circuit Fault	Code 81 will set if the PCM/TCM detects an inappropriate voltage on the 2-3 shift solenoid circuit.	• Maximum line pressure. • Inhibit TCC operation. • 2nd gear only.
82 1-2 Shift Solenoid Circuit Fault	Code 82 will set if the PCM/TCM detects an inappropriate voltage on the 1-2 shift solenoid circuit.	• 2nd and 3rd gears only or 1st and 4th gears only.
83 TCC Solenoid Circuit Fault	Code 83 will set if an inappropriate voltage is detected on the TCC circuit.	• Inhibit 4th gear. • Inhibit TCC operation.
84** Accelerator Pedal Position (APP) Circuit Fault	Code 84 will set when the PCM/TCM detects an intermittent APP fault and there are no other current APP faults stored.	• A current and history code will set. • Vehicle operates at limited power.
85 Undefined Ratio	Code 85 will set if the PCM/TCM's calculations indicate an unexpected gear ratio does not include over drive. Slipping clutches, refer to three column Diagnosis Charts for "No Third Gear".	• Set pressure to maximum.
86 Low Ratio	Code 86 will set if the PCM/TCM has commanded 1st or 2nd gear but a ratio calculation indicates 3rd gear. Refer to three column Diagnosis Charts for "Third & Fourth Gear, Only" and "Fourth Gear Starts".	• No default action.
87 High Ratio	Code 87 will set if the PCM/TCM has commanded 3rd or 4th gear but a ratio calculation indicates 2nd gear. Refer to three column Diagnosis Charts for "First & Second Gear, Only" and "No Third Gear".	• No default action.
99** Accelerator Pedal Position (APP) 2 5 Volt Reference Fault	Code 99 will set when reference voltage on APP 2 is below 4.8 volts for 2 seconds.	• "Service Throttle Soon" lamp on. • Vehicle operates at limited power.

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

RH0017-4L80-E

Figure 17 Malfunction Diagnostic Trouble Code (DTC) Diagnosis Chart D

ELECTRONIC COMPONENT MALFUNCTIONS

This chart gives some general information about electronic component malfunctions. Use this information to become familiar with possible conditions caused by transmission/vehicle electrical components. Refer to the diagnosis charts in Section 7A-17C for more specific information.

COMPONENT/SYSTEM	CAN EFFECT
Throttle Position Sensor (TP Sensor) Accelerator Pedal Position Sensor	- Shift pattern (erratic). - Line pressure (high or low). - Engine (rough).
Engine Speed Sensor	- TCC apply (at wrong time, or no apply).
Automatic Transmission Input Speed Sensor Asm.	- TCC apply (no apply).
Automatic Transmission Output Speed Sensor Asm. (Vehicle Speed Sensor)	- Shift pattern (erratic). - TCC apply (at wrong time).
Pressure Control Solenoid	- Line pressure (high or low). - Shift quality (harsh or soft).
Torque Converter Clutch PWM Solenoid	- TCC apply (timing, harsh or soft).
Automatic Transmission Fluid Pressure Switch Asm.	- TCC apply (won't apply). - Fourth gear (no fourth gear). - Shift quality (harsh). - Line pressure (high).
Automatic Transmission Fluid Temperature Sensor Asm.	- TCC control (on or off).
Engine Temperature Sensor	- TCC control (no apply).
Shift Solenoids	- Gear application (wrong gear, only two gears, no shift).
Four Wheel Drive Low Switch	- Shift Pattern (erratic).
Cruise Engaged	- Delays fourth gear. - Delays TCC
TCC Brake Switch	- TCC apply (no apply).

RH0018-4L80-E

Figure 18 Electronic Component Malfunctions

CONDITION	INSPECT COMPONENT	FOR CAUSE
HIGH LINE PRESSURE	• Pressure Regulator Valve (231) • Reverse Boost Valve (228) • Retainer Pin (211) • Orificed Plug (210) • Pressure Control Solenoid (320) • PCM • Possible Codes ** – 73 Pressure Control Solenoid Current	– Stuck at high torque signal due to under-sized bore or sediment. – Stuck at high torque signal due to under-sized bore or sediment. – Broken. – Blocked. – Failed “off”. – Loose connector. – Loose connector.
FORWARD MOTION IN N	• Manual Valve (319) • Forward Clutch Springs (607) • Forward Clutch Piston (606) • Forward Clutch Plates (610, 611) • Forward Clutch Housing (602) • Hub (613)	– Mispositioned or stuck. – Jammed. – Jammed. – Seized or jammed. – Hole plugged. – Holes plugged.
INADEQUATE LUBE AT LOW LINE OR HEAVY VEHICLE LOADS	• Converter Limit Valve (214) • Retainer Pin (211)	– Stuck closed by sediment or valve bore collapse. – Broken.
INADEQUATE LUBE	• Pressure Regulator Valve (231) • Pump Body (206) • Gasket (6) • Oil Transfer Hole Cup Plug	– Stuck in high demand position. – Cross channel leakage. – Damaged. – Leaking.
ENGINE STALL	• TCC System	– TCC stuck on or dragging.
LOSS OF POWER	• Transmission • TCC System • Torque Converter (1) • Stator Shaft (235) • Turbine Shaft (502) • Main Shaft (662) • Output Shaft (671) • Bearing (668)	– Low oil. – Not starting in first gear. – TCC stuck on or dragging. – Debris. – Broken. – Bushing worn. – Bushing worn. – Bushing worn. – Worn.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

** REFER TO MALFUNCTION CODE DIAGNOSIS AND DEFAULT ACTION CHART

RH0019-4L80-E

Figure 19 Diagnosis Chart A

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO TORQUE IN REVERSE AND THIRD	• Forward Clutch Hub (613) • Snap Ring (616a) • Forward Clutch Housing (602)	– Broken. – Not seated. – Broken.
TRANS OVERHEATS	• TCC Circuit • TCC Valve Spring (224) • Pump Cover (206) • Pressure Regulator Valve (231) • Oil Cooler • Gasket (6) • Retainer Pin (211) • Turbine Shaft O-ring (2) • Turbine Shaft Seals (503) • Stator Shaft Bushing (233) • Oil Transfer Hole Cup Plug • Fluid • Radiator	– Blockage in apply or release. – Broken. – Cross channel leakage. – Stuck in high demand position. – Blocked cooler or cooler lines. – Damaged. – Broken. – Damaged. – Damaged. – Worn or damaged. – Leaking. – Low fluid level. – Restricted air flow.
@ WOT	• Converter Limit Valve Bypass Orificed Cup Plug	– Blocked, therefore converter limit valve stuck closed.
LOW LINE PRESSURE	• Pump (203) • Pressure Regulator Valve (231) • Reverse Boost Valve (228) • Pump Valve Bores • Spring (230) • Retainer Pin (211) • Valve Body (301) • Gasket/Spacer Plate • Pressure Control Solenoid (320) • PCM • Possible Codes ** – 73 Pressure Control Solenoid Current	– Cross channel air leak at body to cover, or body to case gasket. – Stuck at low torque signal due to under-sized bore or sediment. – Stuck at low torque signal due to under-sized bore or sediment. – Excessive valve clearance due to wear. – Broken. – Broken. – Cross channel leaks. – Cross valve land leaks. – Damaged or missing. – Stuck “on”. – Broken clip causing leakage. – Pinched wire to ground. – Screen missing. – Failed.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0020-4L80-E

Figure 20 Diagnosis Chart B

CONDITION	INSPECT COMPONENT	FOR CAUSE
ENGINE STARTS IN GEAR	• Manual Valve (319) • Neutral Safety Switch	– Not engaged to detent lever. – Stuck in wrong position. – Not working.
SHIFT LEVER INDICATES WRONG GEAR	• Manual Valve (319) • Detent Pin (711) • Manual Shaft (708) • Indicator Linkage	– Not engaged to detent lever. – Misaligned or broken. – Flats not parallel. – Misadjusted.
NO GEAR SELECTIONS	• Detent Lever (711) • Manual Valve (319) • Spacer Plate (46) • Valve Body/Case (301, 7)	– Nut loose or missing. – Stuck. – Blocked holes. – Blocked channels.
LOSS OF DRIVE	• Torque Converter (1) • Pump (203) • Case Extension Seal (20) • Orifice Plate • Gasket (6) • Oil Transfer Hole Cup Plug • Seals (503) • Housing (504) • Roller Clutch (512) • Carrier (514) • Pinions (518) • Bearing (513) • Roller Clutch (644) • Turbine Shaft (502)	– Broken lug, failed lug welds. – Sheared lug bolts. – Worn turbine shaft splines. – Low oil. – Pump hub cracked, scored or broken. – Internal failure. – Closure weld failure. – Cover cracked at lug weld. – Seized. – Broken pump gears. – Missing, damaged or displaced. – Missing or leaking around edge. – Damaged. – Leaking or missing. – Damaged or missing. – Broken. – Worn, broken or locked. – Broken. – Broken free from pilot. – Spalled pins or pinions. – Plugged pinion pin holes. – Worn thrust washers. – Lack of lube. – Broken. – Worn, broken or locked. – No lube. – Shaft or splines broken.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0021-4L80-E

Figure 21 Diagnosis Chart C

CONDITION	INSPECT COMPONENT	FOR CAUSE
LOSS OF DRIVE (Continued)	(Forward Clutch Components) • Seals (603, 604, 605) • Checkball • Piston (606) • Housing (602) • Friction Plates (611) • Reaction Plates (610) • Spring Assembly (607) • Driving Hub (615) • Snap Ring (616) • Driven Hub (613)	– Nicked or cut. – Leaking. – Cracked or jammed. – Cracked. – Burned or splines worn. – Worn or splines worn. – Jammed. – Broken. – Not seated. – Gear teeth worn.
	(Rear Gearset) • Pinions (655) • Pinion Pins (656) • Needle Bearings (654) • Sun Gear (649) • Pinion Thrust Washers (652) • Rear Internal Gear (666) • Front Internal Gear (661) • Turbine Shaft Ball Seal • Main Shaft (662) • Fluid Pressure	– Broken or spalled. – Broken or spalled. – Broken or spalled. – Broken or spalled. – Worn. – Broken or spalled. – Broken or spalled. – Ineffective. – Shaft or splines broken. – Too low.
P NO PARK	• Detent Lever (711) • Actuator Rod (710) • Detent Spring (41) • Parking Pawl (703) • Pawl Shaft (702) • Park Bracket (713) • Bolt (714) • Front Internal Gear (661) • Manual Shaft (708)	– Incomplete travel. – Misaligned. – Rabbit ears bent, disconnected or broken. – Mispositioned. – Broken. – Broken. – Bent or broken. – Loose or broken. – Splines broken. – Flats not parallel.
REMAINS IN PARK	• Actuator Rod Assembly (710)	– Stretched.
DIFFICULT TO SHIFT OUT OF PARK	• Pawl Return Spring (705) • Vehicle	– Weak or broken. – Parked on hill.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0022-4L80-E

Figure 22 Diagnosis Chart D

CONDITION	INSPECT COMPONENT	FOR CAUSE
WILL NOT STAY IN PARK	• Detent Spring (41)	– Weak or broken.
R NO REVERSE	• Case (7) • Center Support (640) • Center Support Seal (639) • Center Support Bolt (25) • Rear Band (657) • Rear Band Apply Pin (73) • Piston (65) • Seal (66) • Gasket (63) • Cover (62) • Bolts (61) • Checkball • Fluid Pressure	– Rear band anchor pin broken or not positioned. – Leaking at case or broken. – Leaking. – Loose, broken or feed hole blocked. – Broken, worn or not anchored. – Too short or binding in case. – Binding in case. – Leaking, damaged or worn. – Damaged or displaced. – Damaged. – Broken, loose or missing. – Missing. – Too low.
	(Direct Clutch Components) • Reaction Plates (618) • Friction Plates (611) • Spring Assembly (607) • Housing (623) • Piston (619) • Seal (620, 621, 622) • Ball Check	– Splines worn. – Splines or friction worn. – Jammed. – Cracked. – Leaking. – Leaking. – Leaking.
D1 NO FIRST GEAR	* See D4 – No First Gear • Housing (504) • Case (7) • Detent Lever (711)	– Broken. – Rear band anchor pin broken or not positioned. – Misaligned.
NO SECOND GEAR (SOME MODELS)	* See D4 – No Second Gear	
NO OVERRUN BRAKING	* See D3 – No Overrun Braking • Possible Codes ** – 28 A/Transmission Fluid Pressure Switch Asm. – 68 Overdrive Ratio – 85 Undefined Ratio	

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0023-4L80-E

Figure 23 Diagnosis Chart E

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO OVERRUN BRAKING (Continued)	• A/Transmission Fluid Pressure Switch Asm. (40)	– Pinched wire. – Loose connector. – Loose bolt causing leakage. – No signal to PCM.
NO ENGINE BRAKING	• Rear Band (657) • Rear Band Apply Pin (73) • Piston (65) • Seal (66) • Cover (62) • Gasket (63) • Bolt (61) • Checkball • Fluid Pressure • Output Shaft (671) • Main Shaft (662) • Thrust Washer (218) • Bushing (234)	– Damaged, worn or not anchored. – Too short or binding in case. – Binding in case. – Worn or damaged. – Damaged. – Damaged or missing. – Loose, broken or missing. – Missing, damaged, not sealing or mis-sized. – Too low. – Shaft or splines broken. – Shaft or splines broken. – Worn or damaged. – Worn or damaged.
D2 NO FIRST GEAR	* See D4 – No First Gear • Front Band (628)	– Stuck on.
NO SECOND GEAR	* See D4 – No Second Gear • Case (7)	– Front band anchor pin broken or not properly positioned. – Intermediate clutch feed cup plug missing or not seated.
NO OVERRUN BRAKING	* See D3 – No Overrun Braking	
NO ENGINE BRAKING	• Bushing (234) • Thrust Washer (218) • Rear Gearset • Reaction Drum & Carrier (651) • Main Shaft (662) • Output Shaft (671) • Sun Gear Shaft (649)	– Worn or damaged. – Worn or damaged. – Spalled or broken. – Broken. – Shaft or splines broken. – Shaft or splines broken. – Shaft or splines broken.
NO SECOND GEAR ENGINE BRAKING	• Fluid Pressure • Direct Clutch Housing (623)	– Too low. – Internal diameter splines worn. – Outer band surface worn.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0024-4L80-E

Figure 24 Diagnosis Chart F

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO SECOND GEAR ENGINE BRAKING (Continued)	• Front Band (628) • Apply Pin (55) • Apply Clip (56) • Piston (58) • Seal (57) • Case (7) • Spacer Plate (46) • Gasket (48) • Valve Body Bolts (35)	– Broken, worn or not anchored. – Too short or binding in case. – Broken or missing. – Cracked, broken or binding. – Damaged or worn. – Cracked or damaged. – Damaged. – Torn or pinched. – Loose, broken or missing.
D3 NO FIRST GEAR	* See D4 – No First Gear • Front Band (628)	– Stuck on.
NO SECOND GEAR	* See D4 – No Second Gear	
NO THIRD GEAR	* See D4 – No Third Gear • Front Band (628)	– Stuck on.
NO OVERRUN BRAKING	• Clutch Plates (508, 509) • Thrust Washer (218) • Output Shaft (671) • Seals • Checkball • Piston (505) • Housing (504) • Sun Gear (650) • Spring Assembly (506) • Oil Feed	– Splines or plate wear. – Damaged or worn. – Shaft or splines broken. – Cut or nicked. – Leaking. – Jammed, cracked or damaged. – Cracked or damaged. – Worn. – Jammed. – Plugged.
NO ENGINE BRAKING	• Main Shaft (662) • Bushing (234)	– Shaft or splines broken. – Damaged or worn.
D4 NO FIRST GEAR	• Low Roller Assembly (644) • Center Support (640) • Case (7) • Snap Rings (633, 643)	– Not attached or race broken. – Support or splines broken. – Damaged near center support. – Not seated.
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.		

RH0025-4L80-E

Figure 25 Diagnosis Chart G

CONDITION	INSPECT COMPONENT	FOR CAUSE
FIRST GEAR ONLY	• Sun Gear Shaft (649) • A/Transmission Output Speed Sensor Asm. (22) • A/Transmission Input Speed Sensor Asm. (22)	– Shaft or splines broken. – Reads zero. – Reads zero.
FIRST AND SECOND GEAR ONLY	• 2-3 Solenoid (311) • 2-3 Shift Valve (312) • Quad Driver Module • Possible Codes ** – 68 Overdrive Ratio – 81 QDM & 2-3 Solenoid Fault – 85 Undefined Ratio – 87 2-3 Solenoid Stuck "Off"	– Stuck "off". – Loose connector. – No voltage to solenoid. – Solenoid o-ring failure. – No PCM signal to solenoid. – Stuck. – Failed.
SECOND GEAR ONLY	• Possible Codes ** – 24 A/Transmission Output Speed Sensor Asm. – 53 System Voltage High – 75 System Voltage Low – 81 QDM & 2-3 Solenoid	
SECOND AND THIRD GEARS ONLY	• 1-2 Solenoid (313) • 1-2 Shift Valve (314) • Quad Driver Module • Possible Codes ** – 68 Overdrive Ratio – 82 QDM & 1-2 Solenoid Fault – 85 Undefined Ratio	– Stuck "off". – No voltage to solenoid. – Loose connector. – Solenoid o-ring failed. – No PCM signal to solenoid. – Stuck. – Failed.
FIRST AND FOURTH GEAR ONLY (Second And Third Gear Available In D3 And D2)	• 1-2 Solenoid (313) • 1-2 Shift Valve (314) • Quad Driver Module • Possible Codes ** – 68 Overdrive Ratio – 82 QDM & 1-2 Solenoid Fault – 85 Undefined Ratio	– Stuck "on". – Pinched wire to ground. – Stuck. – Failed.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0026-4L80-E

Figure 26 Diagnosis Chart H

CONDITION	INSPECT COMPONENT	FOR CAUSE
THIRD AND FOURTH GEAR ONLY (Second Gear Available In D3 And D2)	• 2-3 Solenoid (311) • 2-3 Shift Valve (312) • Quad Driver Module • Possible Codes ** – 81 QDM & 2-3 Solenoid Fault – 85 Undefined Ratio – 86 2-3 Solenoid Stuck "On"	– Stuck "on". – Pinched wire to ground. – Stuck. – Failed.
NO SECOND GEAR	• Case (7)	– Intermediate clutch feed cup plug missing or not seated.
	(Intermediate Clutch Components) • Backing Plate (630) • Snap Ring (633) • Friction Plates (631) • Outer Race (625) • Center Support (640) • Center Support Bolt (25) • Seals (637, 638) • Piston (636) • Springs (635) • Transmission Fluid • Intermediate Sprag (624) • Direct Clutch Housing (623) • Snap Ring (627)	– Broken. – Missing or not seated. – Worn. – Splines worn. – Cracked or feed hole blocked. – Broken or loose. – Oil hole blocked. – Worn. – Cracked or jammed. – Jammed. – Improper fluid. – Additive package. – Outer race splines worn. – Outer race broken. – Splines or inner race worn. – Broken. – Missing or not seated.
NO THIRD GEAR	(Direct Clutch Components) • Seal (620, 621, 622) • Ball Check • Piston (619) • Housing (623) • Reaction Plates (618) • Friction Plates (611) • Spring Assembly (607) • Center Support Seal (639) • Center Support (640)	– Leaking. – Leaking. – Cracked or jammed. – Cracked. – Splines worn. – Splines or friction worn. – Jammed. – Leaking at case. – Broken or leaking at case.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0027-4L80-E

Figure 27 Diagnosis Chart I

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO THIRD GEAR (Continued)	(Direct Clutch Components) • Center Support Bolt (25) • 2-3 Solenoid (311) • 2-3 Shift Valve (312) • PCM • Quad Driver Module • Possible Codes ** – 81 QDM & 2-3 Solenoid Fault – 85 Undefined Ratio – 87 2-3 Solenoid Stuck "Off"	– Loose or broken. – Hole blocked. – Stuck "off". – Pinched wire. – O-ring failure. – No voltage to solenoid. – Stuck. – No signal to solenoid. – Failed.
NO FOURTH GEAR	(Fourth Clutch Components) • Seals (527, 531) • Cup Plug (530) • Bolt (26) • Piston (528) • Spring Assembly (532) • Snap Ring (523) • Friction Plates (525) • Reaction Plates (526) • Housing (529)	– Nicked or cut. – Missing. – Loose, broken or missing. – Jammed. – Jammed. – Not seated. – Worn or burned. – Splines worn. – Damaged or cracked.
	(Overrun Clutch Components) • Housing (504) • Reaction Plates (508) • Sun Gear (650) • 2-3 Solenoid (311) • 2-3 Shift Valve (312) • PCM • Quad Driver Module • Possible Codes ** – 21 TP Sensor High – 22 TP Sensor Low – 28 A/Transmission Fluid Pressure Switch Asm. – 68 Overdrive Ratio – 75 System Voltage Low – 81 QDM & 2-3 Solenoid	– Broken. – Splines worn. – Worn. – Stuck "off". – Pinched wire. – O-ring failure. – No voltage to solenoid. – Stuck. – No signal to solenoid. – Failed.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0028-4L80-E

Figure 28 Diagnosis Chart J

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO TCC	• TCC Solenoid (323) • Quad Driver Module • PCM • Brake Switch • TCC Valve (223) • Retainer Pin (211) • Torque Converter (1) • Turbine Shaft (502) • Turbine Shaft Seals (501) • Pump Body Bushing (202) • O-ring (2) • Oil Transfer Hole Cup Plug • Regulated Apply Valve (324) • TCC Valve Release Exhaust Orificed Cup Plug • Possible Codes ** – 24 TP Sensor High – 27 TP Sensor Low – 28 A/Transmission Fluid Pressure Switch Asm. – 37 Brake Switch Stuck "On" – 39 TCC Stuck "Off" – 53 System Voltage High – 68 Overdrive Ratio – 75 System Voltage Low – 81 QDM & 2-3 Solenoid – 83 QDM & TCC Solenoid * See Incorrect TCC Apply Or Release	– Stuck "off". – O-ring failed. – No voltage to solenoid. – Poor connection. – Failed. – No signal to solenoid. – Contact corroded. – Poor connection. – Pinched wire. – Misadjusted. – No supply voltage. – Stuck off due to sediment or undersized bore. – Broken. – Ballooning. – Plugged oil holes. – Ineffective. – Worn. – Heat set. – Leaking. – Stuck. – Blocked.
SOFT TCC APPLY	• Turbine Shaft Seals (501) • Pump Body Bushing (202) • O-ring (2) • Oil Transfer Hole Cup Plug • TCC Solenoid (323) • Fluid	– Ineffective. – Worn. – Heat set. – Leaking. – Malfunction. – Low pressure.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0029-4L80-E

Figure 29 Diagnosis Chart K

CONDITION	INSPECT COMPONENT	FOR CAUSE
SLIPPING TCC	• TCC Valve Release Exhaust Orificed Cup Plug • Turbine Shaft Seal	– Blocked. – Cut.
TCC STUCK ON	• Gasket (6) • TCC Solenoid (323) • TCC Apply Valve (324) • Quad Driver Module • Possible Codes ** – 83 QDM & TCC Solenoid * See Incorrect TCC Apply Or Release	– Damaged. – Stuck “on”. – Pinched wire to ground. – Stuck. – Failed.
INCORRECT TCC APPLY OR RELEASE	• A/Transmission Output Speed Sensor Asm. (22) • Throttle Position Sensor • PCM/TCM • A/Transmission Fluid Pressure Switch (40) • A/Transmission Fluid Temperature Sensor Asm. (332) • Engine Coolant (Gas Only) • A/Transmission Fluid Temperature Sensor Asm. (Diesel Only) • Brake Switch • Engine Ignition Module (Gas Only) • Engine Tachometer (Diesel Only) • Possible Codes ** – 14 Engine Temperature Sensor High – 15 Engine Temperature Sensor Low – 21 Throttle Position Sensor High	– Poor connection. – Pinched wire. – Coil wire broken. – Incorrect air gap. – Inadequate signal. – Poor connection. – Pinched wire. – Incorrect resistance. – Failed. – Poor connection. – No signal to PCM/TCM. – Pinched wire. – Poor connection. – No signal to PCM. – Incorrect resistance. – Pinched wire. – No signal to PCM/TCM. – No signal to PCM/TCM. – Poor connection. – Pinched wire. – No voltage supply. – Misadjusted. – Loss of signal or intermittent. – Loss of signal or intermittent.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0030-4L80-E

Figure 30 Diagnosis Chart L

CONDITION	INSPECT COMPONENT	FOR CAUSE
INCORRECT TCC APPLY OR RELEASE (Continued)	• Possible Codes (Cont.) ** – 22 Throttle Position Low – 24 A/Transmission Output Speed Sensor Asm. – 28 A/Transmission Fluid Pressure Switch Asm. – 58 A/Transmission Fluid Temperature Sensor High – 59 A/Transmission Fluid Temperature Sensor Low – 68 Overdrive Ratio	
Only 2WD	• Digital Ratio Adapter (DRAC)	– Malfunction. – Incorrect.
CONVERTER BALLOONING	• Converter Limit Valve (214)	– Stuck open due to sediment or undersized bore.
@ High Speeds	• Converter Limit Valve Feedback Orificed Cup Plug	– Blocked.
NO TORQUE MULTIPLICATION	• Stator Shaft (235)	– Broken or detached from pump cover.
FLUID FOAMING	• Fluid • Engine • Filter (31) • Seal (32) • Vehicle	– Contaminated (antifreeze). – Transmission overfilled. – Overheated. – Cracked or not seated. – Damaged or not seated. – Overloaded.
NOISE	• Torque Converter (1) • Transmission/Engine • Case Extension (19)	– Loose lug bolts. – Out of balance. – Internal failure. – Misaligned. – Output shaft support bushing worn.
VIBRATION	• Torque Converter (1) • Transmission/Engine • Case Extension (19) • Turbine Shaft (502) • Main Shaft (662) • Output Shaft (671) • Bearing (668)	– Out of balance. – Internal failure. – Misaligned. – Output shaft support bushing worn. – Worn stator shaft bushing surface. – Worn bushing. – Worn bushing. – Worn.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0031-4L80-E

Figure 31 Diagnosis Chart M

CONDITION	INSPECT COMPONENT	FOR CAUSE
ENGINE STALL	• Forward Clutch Housing (602)	– Seized bearing if holes plugged.
	(Fourth Clutch Components) • Plates (525, 526) • Piston (528) • Spring Assembly (532)	– Seized or jammed. – Jammed. – Jammed.
	(Overrun Clutch Components) • Plates (508, 509) • Piston (505) • Spring Assembly (506)	– Seized or jammed. – Jammed. – Jammed.
OIL OUT BREATHER TUBE	• Pump Cover (206) • Fluid • Transmission	– Cross channel leakage can pressurize vent area. – Foaming and filling pump vent ports. – Transmission overfilled. – Overheated.
NO TORQUE IN SECOND GEAR	• Intermediate Sprag (624)	– Worn. – Excessive eccentricity. – Sprag rolled over or damaged.
SECOND GEAR STARTS	• Intermediate Clutch Plates (631, 632) • Direct Clutch Lube Feed • Center Support Springs (635) • Center Support Piston (636) • 1-2 Solenoid (313) • PCM • Quad Driver Module • 1-2 Shift Valve (314) • Possible Codes ** – 82 QDM & 1-2 Solenoid	– Seized. – Blocked. – Jammed. – Jammed. – Stuck “off”. – O-ring failed. – No voltage to solenoid. – Poor connection. – To PCM signal to solenoid. – Failed. – Stuck.
THIRD GEAR STARTS	(Forward Clutch Components) • Driving Hub (615) • Plates (610, 611)	– Holes plugged. – Seized.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0032-4L80-E

Figure 32 Diagnosis Chart N

CONDITION	INSPECT COMPONENT	FOR CAUSE
THIRD GEAR STARTS (Continued)	(Direct Clutch Components) • Plates (611, 618) • Piston (619) • Spring Assembly (607) • Lube Feed Hole	– Seized. – Jammed. – Jammed. – Blocked.
FOURTH GEAR STARTS	• 2-3 Solenoid • Possible Codes ** – 86 2-3 Solenoid Stuck “On”	– Stuck “on”. – Pinched wire to ground.
ERRATIC SHIFT QUALITY	• Gasket (6) • Oil Transfer Hole Cup Plug • Oil Seal Rings (219)	– Damaged. – Leaking. – Damaged.
TRANSMISSION SLIPS	• Fluid Level	– Too high or low.
TRANSMISSION SEIZED	(Rear Lube Components) • Cooler Circuit • Spacer Plate/Gasket • Lube Pipe (39) • Valve Body (301) • Filter (Inline) • Output Shaft Seal (20) • Main Shaft (662) • Center Support (640) • Apply Pin (55) • Piston (58) • Snap Ring (643) • Sun Gear Shaft (649) • Rear Gearset • Main Shaft (662)	– Blocked or leaking. – Hole missing. – Poor seal. – Damaged. – Missing clips. – Loose, broken or missing bolts. – Blocked. – Missing or damaged. – Lube holes missing or blocked. – Lube holes missing or blocked. – Lube holes missing or blocked. – Not held. – Too long. – Binding in case. – Binding in case. – Not seated. – Bearing surface worn. – Lube hole blocked. – Bearing surface worn. – Lube holes plugged.
In 2nd, 3rd and 4th	• Rear Band (657) • Rear Servo Pin (73) • Piston (65)	– Locked on. – Too long or binding in case. – Binding in case.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0033-4L80-E

Figure 33 Diagnosis Chart O

CONDITION	INSPECT COMPONENT	FOR CAUSE
CASE EXTENSION BEARING/SEAL FAILED	• Orifice Plate • Case Extension (19)	– Missing or blocked hole. – Lube passages blocked or missing.
INACCURATE SHIFT POINTS	• A/Transmission Output Speed Sensor Asm. (22) • Throttle Position Sensor • A/Transmission Fluid Pressure Switch Asm. • Possible Codes ** – 21 Throttle Position Sensor High – 22 Throttle Position Sensor Low – 24 A/Transmission Output Speed Sensor Asm. – 28 A/Transmission Fluid Pressure Switch Asm. – 85 Undefined Ratio • Axle Ratio • Tire Size	– Pinched or broken wire. – Loose connector. – Air gap incorrect. – Inadequate signal. – Coil damaged. – Damaged rotor teeth. – Loose connection. – Pinched or damaged wire. – Incorrect resistance. – Loose connector. – PCM malfunction. – Loose connector. – Loose bolts causing leakage. – Pinched wire. – No signal to PCM. – Incorrect or changed from original. – Incorrect or changed from original.
Only 2WD	• Digital Ratio Adapter (DRAC)	– Incorrect. – Malfunction.
HARSH SHIFT	• Line Pressure • Pressure Control Solenoid (320) • PCM • Accumulator Piston • Accumulator Spring • Checkballs • Calibration PROM • Possible Codes ** – 21 TP Sensor High – 22 TP Sensor Low – 24 A/Transmission Output Speed Sensor Asm.	– Too high. – Too low. – Failed “off”. – Loose connector. – Loose connector. – Leaking. – Stuck. – Incorrect. – Missing. – Incorrect.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0034-4L80-E

Figure 34 Diagnosis Chart P

CONDITION	INSPECT COMPONENT	FOR CAUSE
HARSH SHIFT (Continued)	• Possible Codes (Cont.) ** – 28 A/Transmission Fluid Pressure Switch Asm. – 53 System Voltage High – 68 Overdrive Ratio – 73 Pressure Control Solenoid Current – 75 System Voltage Low – 81 QDM & 2-3 Solenoid – 85 Undefined Ratio	
D To R	• Direct Lube Exhaust • Forward Clutch Spring (607) • Snap Ring (616) • Checkball	– Blocked. – Not acting. – Not seated. – Plugged.
3-4	• Spring Assembly (532) • Air Bleed • Bolt (26)	– Not compressing evenly. – Plugged. – Oil feed hole plugged.
4-3	• Snap Ring (533) • Spring Assembly (532) • Bolt (26) • Cup Plug (530) • Direct Lube Exhaust	– Not seated. – Not acting. – Oil feed hole plugged. – Plugged. – Blocked.
D4 To D3 , D2 Or D1	• Spring Assembly (506) • Checkball • Snap Ring (511)	– Not functioning. – Plugged. – Not seated.
SOFT SHIFT	• Line Pressure • Pressure Control Solenoid (320) • PCM • Accumulator Piston • Accumulator Spring • Calibration PROM • Possible Codes ** – 73 Pressure Control Solenoid Current	– Too low. – Stuck “on”. – Broken clip causing leakage. – Pinched wire to ground. – Failed. – Leaking. – Stuck. – Incorrect. – Incorrect.
Into R	• Direct Clutch Oil Feed • Direct Lube Exhaust	– Plugged. – Blocked.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0035-4L80-E

Figure 35 Diagnosis Chart Q

CONDITION	INSPECT COMPONENT	FOR CAUSE
SOFT SHIFT (Continued) R To D	• Direct Clutch Spring (607) • Snap Ring (616b) • Ball Check	– Not acting. – Not engaged or missing. – Plugged.
2-1	• Center Support Springs (635) • Snap Ring (634) • Center Support (640)	– Not acting. – Not seated. – Air bleed blocked.
2-3	• Direct Clutch Oil Feed • Direct Lube Exhaust	– Plugged. – Blocked.
3-2	• Direct Spring Assembly (607) • Snap Ring (608) • Ball Check	– Not acting. – Not engaged or missing. – Plugged.
D3 To D2	• Ball Check • Orifices	– Missing. – Incorrect sizes.
DELAYED 1-2 SHIFT	• A/Transmission Output Speed Sensor Asm. (22) • A/Transmission Input Speed Sensor Asm. (22) • A/Transmission Fluid Pressure Switch Asm. (40) • Calibration PROM • Possible Codes ** – 24 A/Transmission Output Speed Sensor Asm. – 28 A/Transmission Fluid Pressure Switch Asm. – 85 Undefined Ratio	– Pinched or broken wire. – Loose connector. – Air gap incorrect. – Inadequate signal. – Coil damage. – Pinched or damaged wire. – Coil damage. – Inadequate signal. – Loose connector. – Pinched wire. – No signal to PCM. – Loose bolts causing leakage. – Incorrect.
Only 2WD	• Digital Ratio Adapter (DRAC)	– Malfunction. – Loose connector.
NO D2 TO D1	• Rear Band (657) • Detent Lever (711)	– Broken, worn or not anchored. – Incomplete travel.
NO D3 TO D2	• Front Band (628)	– Broken, worn or not anchored.
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.		

RH0036-4L80-E

Figure 36 Diagnosis Chart R

CONDITION	INSPECT COMPONENT	FOR CAUSE
LEAKS AT: OIL PAN	• Oil Pan (28) • Gasket (29) • Case (7) • Bolt (27)	– Damaged or not flat. – Damaged. – Porosity or cracked. – Flange inside out. – High or low torque.
FLUID FILL TUBE	• Seal • Case (7) • Fill Tube • Brackets	– Cut or nicked. – Missing. – Porosity. – Damaged at case end. – Not seated in case. – Out of position causing tension on fill tube.
ELECTRICAL CONNECTOR	• Electrical Connector • O-ring Seal • Case (7)	– Damaged or not seated. – Cut or nicked. – Missing. – Porosity or cracked.
COOLER CONNECTORS	• Cooler Connectors (8) • Case (7)	– Stripped threads. – Damaged flare. – High or low torque. – Stripped threads. – Porosity. – Debris in threads.
CASE EXTENSION	• Case Extension (19) • Case (7) • Seal (15) • Bolt (21)	– Porosity or cracked. – Porosity or cracked. – Cut or nicked. – Missing. – Low torque. – Missing.
MANUAL SHAFT	• Seal (707) • Linkage	– Cut or nicked. – Not seated. – Misadjusted.
PUMP BODY SEAL	• Seal (201) • Torque Converter (1) • Bolt	– Cut, nicked or worn. – Missing garter spring. – Damaged hub. – Low torque.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0037-4L80-E

Figure 37 Diagnosis Chart S

CONDITION	INSPECT COMPONENT	FOR CAUSE
LEAKS AT: (Continued) VEHICLE SPEED SENSOR ASM.	• Seal • Vehicle Speed Sensor Asm. (22) • Bolt (23) • Case (7)	– Cut, missing, nicked. – Damaged. – Not seated. – Bracket damaged. – Low torque. – Missing. – Damaged threads. – Porosity or cracked.
OUTPUT SHAFT SEAL	• Seal (20) • Case (7)	– Cut or nicked. – Porosity or cracked.
LINE PRESSURE PLUG	• Plug (24) • Case (7)	– Stripped threads. – Low or high torque. – Porosity or cracked. – Damaged threads.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L80-E UNIT REPAIR SECTION.

RH0038-4L80-E

Figure 38 Diagnosis Chart T

GARAGE SHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	PARK	DRIVE 4	REVERSE
ENGINE SPEED	670 RPM	630 RPM	640 RPM
TRANS FLUID TEMP	34°C	34°C	34°C
A / B / C RNG	ON OFF ON	ON OFF OFF	OFF OFF ON
TRANS RANGE SW	P – N	DRIVE 4	REVERSE
DESIRED PCS	.9 AMPS	.9 AMPS	.9 AMPS
ACTUAL PCS	.9 AMPS	.9 AMPS	.9 AMPS

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

- ENGINE SPEED should drop approximately 40 RPM.
 - This verifies that the transmission has engaged.
- When DESIRED PCS = 1.10 AMPS, the transmission is commanded to minimum line pressure.
- ACTUAL PCS AMPS should always be within .16 AMPS of DESIRED PCS.
- PRNDL SWITCH should match the selected gear range.
 - IF not, the Transmission Pressure Switch Assembly should be checked.
 - A / B / C RNG should be used to identify the failed circuit.

RH0039-4L80-E

Figure 39 Example of TECH 1 Information (Garage Shifts)

1-2 UPSHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	1ST GEAR	2ND GEAR
ENGINE SPEED	2286 RPM	2204 RPM
TRANS OUTPUT SPD	817 RPM	1316 RPM
TRANS FLUID TEMP	61°C	61°C
** ACCEL PED POS 1	1.86 VOLTS	1.82 VOLTS
** ACCEL PED POS 2	3.26 VOLTS	3.28 VOLTS
** ACCEL PED POS 3	3.4 VOLTS	3.4 VOLTS
†† THROTTLE POSITION	2.16 VOLTS	2.16 VOLTS
THROTTLE ANGLE	40%	40%
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	1	2
1-2 SOL 2-3 SOL	ON OFF	OFF OFF
** CTR FDBK 1/2 2/3	OK OK	OK OK
† CTR FDBK 1/2 2/3	ON OFF	OFF OFF
TRANS INPUT SPD	2023 RPM	1995 RPM
**† 4WD LOW SWITCH	NO	NO
1-2 SHIFT TIME	0.45 SEC	0.55 SEC
TRANS GEAR RATIO	2.49	1.48

*THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

*THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

†† CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

NO 1-2 UPSHIFT

- TRANS OUTPUT SPD must be greater than 350 RPM to upshift.
 - Refer to 1994 HYDRA-MATIC 4L80-E SHIFT SPEED CHART.
- TURBINE SPEED equals TRANS INPUT SPD in first, second and third gear.
- TRANS GEAR RATIO must equal 1.48 to actually be in second gear.
- TRANS RANGE SW should match the selected gear range.
- THROTTLE ANGLE should equal 0% at idle and increase as the accelerator is depressed until it equals 100% at wide open throttle.
 - If it decreases, check the Accelerator Pedal Position Module or the Throttle Position Sensor depending on the application.
- If COMMANDED GEAR changes from 1 to 2 and the vehicle does not shift (TRANS GEAR RATIO should drop approximately from 2.48 to 1.48).
 - ** CTR FDBK 1/2 2/3 should display OK.
 - If one displays FAULT, that shift solenoid should be checked.
 - † CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-17A).

HARSH OR SOFT 1-2 UPSHIFT

- 1-2 SHIFT TIME is normally between 0.2 SEC and 1.35 SEC however the Tech 1 will display the last shift time. If the conditions of the last shift are unknown (lift foot upshift or manual upshift), it is recommended to repeat the upshift in the following manner.
 - To achieve an accurate shift time.
 - Accelerate the vehicle from rest holding the throttle steady.
 - If not, refer to Diagnosis Charts (7A-17A).

RH0040-4L80-E

Figure 40 Example of Tech 1 Information (1-2 Upshifts)

2-3 UPSHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	2ND GEAR	3RD GEAR
ENGINE SPEED	2546 RPM	2169 RPM
TRANS OUTPUT SPD	1566 RPM	1826 RPM
TRANS FLUID TEMP	47°C	47°C
** ACCEL PED POS 1	1.46 VOLTS	1.46 VOLTS
** ACCEL PED POS 2	3.64 VOLTS	3.64 VOLTS
** ACCEL PED POS 3	3.62 VOLTS	3.62 VOLTS
†‡ THROTTLE POSITION	1.5 VOLTS	1.5 VOLTS
THROTTLE ANGLE	25%	25%
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	2	3
1-2 SOL 2-3 SOL	OFF OFF	OFF ON
** CTR FDBK 1/2 2/3	OK OK	OK OK
† CTR FDBK 1/2 2/3	OFF OFF	OFF ON
TRANS INPUT SPD	2319 RPM	1821 RPM
4WD LOW SWITCH	NO	NO
2-3 SHIFT TIME	0.35 SEC	0.38 SEC
TRANS GEAR RATIO	1.48	1.00

*THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

*THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

NO 2-3 UPSHIFT

- TRANS OUTPUT SPD must be greater than 750 RPM to upshift.
 - Refer to 1994 HYDRA-MATIC 4L80-E SHIFT SPEED CHART.
- TURBINE SPEED equals TRANS INPUT SPD in first, second and third gear.
- TRANS GEAR RATIO must equal 1.00 to actually be in third gear.
- TRANS RANGE SW should match the selected gear range.
 - In Drive 2 the transmission will not upshift to 3rd gear.
- THROTTLE ANGLE should equal 0% at idle and increase as the accelerator is depressed until it equals 100% at wide open throttle.
 - If it decreases, check the Accelerator Pedal Position Module or the Throttle Position Sensor depending on the application.
- If COMMANDED GEAR changes from 2 to 3 and the vehicle does not shift (TRANS GEAR RATIO should equal 1.00 in third gear).
 - ** CTR FDBK 1/2 2/3 should display OK.
 - If one displays FAULT, that shift solenoid should be checked.
 - † CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-17A).

HARSH OR SOFT 2-3 UPSHIFT

- 2-3 SHIFT TIME is normally between 0.2 SEC and 1.35 SEC however the Tech 1 will display the last shift time. If the conditions of the last shift are unknown (lift foot upshift or manual upshift), it is recommended to repeat the upshift in the following manner.
 - To achieve an accurate shift time.
 - Accelerate the vehicle from rest holding the throttle steady.

RH0041-4L80-E

Figure 41 Example of Tech 1 Information (2-3 Upshifts)

3-4 UPSHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	3RD GEAR	4TH GEAR
ENGINE SPEED	2793 RPM	2324 RPM
TRANS OUTPUT SPD	2566 RPM	2700 RPM
TRANS FLUID TEMP	73°C	73°C
THROTTLE ANGLE	57%	41%
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	3	4
1-2 SOL 2-3 SOL	OFF ON	ON ON
** CTR FDBK 1/2 2/3	OK OK	OK OK
† CTR FDBK 1/2 2/3	OFF ON	ON ON
TRANS INPUT SPD	2561 RPM	2717 RPM
**† HOT MODE	NO	NO
**† 4WD LOW SWITCH	NO	NO
**† CRUISE ENGAGED	NO	NO
TRANS GEAR RATIO	1.0	1.0
TURBINE SPEED	2561 RPM	2037 RPM

*THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

*THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

3-4 UPSHIFT INFORMATION

- TRANS OUTPUT SPD must be greater than 1250 RPM to upshift.
 - Refer to 1994 HYDRA-MATIC 4L80-E SHIFT SPEED CHART.
- TRANS INPUT SPD should approximately match TRANS OUTPUT SPD if the transmission is actually in fourth gear. The input speed sensor monitors the forward clutch which is overrunning in fourth gear.
- TURBINE SPEED is based on ENGINE SPEED in fourth gear and it is not very accurate unless TCC is applied. This is due to the input speed sensor monitoring the forward clutch which is overrunning in fourth gear.
- TRANS GEAR RATIO will display between .55 to 1.0 in 4th gear while the TCC is off. Once the TCC applies TRANS GEAR RATIO should display about .75. This is due to the input speed sensor monitoring the forward clutch which is overrunning in fourth gear.
- TRANS RANGE SW should match the selected gear range.
 - In Drive 3 the transmission will not upshift to 4th gear but TCC will normally apply, and COMMANDED GEAR could display 4.
- THROTTLE ANGLE should equal 0% at idle and increase as the accelerator is depressed until it equals 100% at wide open throttle.
 - If it decreases, check the Accelerator Pedal Position module or the throttle position sensor depending on the application.
- If COMMANDED GEAR changes from 3 to 4 and the vehicle does not shift (TRANS GEAR RATIO should equal between .55 to 1.0 in 4th gear).
 - ** CTR FDBK 1/2 2/3 should display OK.
 - If one displays FAULT, that shift solenoid should be checked.
 - † CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-17A).
- If HOT MODE displays YES and if any of the following DTCs are set (21, 22, 28, 37, 38, 74, 83), then 4th gear is not allowed.
- If CRUISE ENGAGED displays YES, then 4th gear uses a shift pattern that requires a higher TRANS OUTPUT SPD.

RH0042-4L80-E

Figure 42 Example of Tech 1 Information (3-4 Upshifts)

FOUR WHEEL DRIVE**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E

5.7L 4L80-E, 7.4L 4L80-E

	IN 4WD LOW	NOT IN 4WD LOW
ENGINE SPEED	1757 RPM	1617 RPM
TRANS OUTPUT SPD	1000 RPM	1000 RPM
COMMANDED GEAR	4	2
**† 4WD LOW SWITCH	YES	NO

*THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

*THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

**UPSHIFTING IN 4WD LOW
(IN 4WD LOW, AND 4WD LOW SWITCH DISPLAYS YES)**

- This is normal operation. The transmission upshifts based on THROTTLE ANGLE and TRANS OUTPUT SPD. In 4WD LOW the transfer case changes the gear ratio between the transmission output shaft and the drive axles. The transmission output shaft must now spin considerably faster to maintain the same vehicle speed. Therefore, in 4WD LOW the transmission upshifts at a lower vehicle speed.

**UPSHIFT TO 4TH GEAR AT A LOW VEHICLE SPEED
(NOT IN 4WD LOW, HOWEVER 4WD LOW SWITCH DISPLAYS YES)**

- If 4WD LOW SWITCH displays YES and the vehicle is not in 4WD LOW, then TRANS OUTPUT SPD will be incorrect. The PCM assumes this value is larger causing the PCM to command upshifts earlier than normal.
- If 4WD LOW SWITCH does not match the 4WD LOW indicator lites, check the 4WD LOW switch.
 - K-Trucks with manual shift 4WD.
 - The switch is located on the transfer case and it grounds a 12V signal from the PCM.

**LATE UPSHIFTS, NO UPSHIFTS OR UPSHIFTS AT HIGH ENGINE SPEED
(IN 4WD LOW, HOWEVER 4WD LOW SWITCH DISPLAYS NO)**

- If 4WD LOW SWITCH displays NO and the vehicle is in 4WD LOW, then TRANS OUTPUT SPD will be incorrect. The PCM assumes this value is smaller causing the PCM to command upshifts later than normal.
- If 4WD LOW SWITCH does not match the 4WD LOW indicator lites, check the 4WD LOW switch.
 - K-Trucks with manual shift 4WD.
 - The switch is located on the transfer case and it grounds a 12 V signal from the PCM.

RH0043-4L80-E

Figure 43 Example of Tech 1 Information (Four Wheel Drive Vehicles)

TCC SYSTEM**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	RELEASED	APPLIED	RELEASED
ENGINE SPEED	2607 RPM	2026 RPM	1593
TRANS OUTPUT SPD	2618 RPM	2689 RPM	1505
TRANS FLUID TEMP	80°C	80°C	80°C
THROTTLE ANGLE	38 %	27 %	18 %
TRANS RANGE SW	DRIVE 4	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	4	4
1-2 SOL 2-3 SOL	ON ON	ON ON	ON ON
TCC SLIP SPEED	+714 RPM	-1 RPM	+409 RPM
**† HOT MODE	NO	NO	NO
TCC PWM SOLENOID	0%	72%	0%
** CTR. FDBK TCC	OK	OK	OK
TCC BRAKE SWITCH	CLOSED	CLOSED	CLOSED
**† CRUISE ENGAGED	NO	NO	NO
TURBINE SPEED	1255 RPM	2021 RPM	1177 RPM

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

* THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

TCC DOES NOT APPLY

- COMMANDED TCC will display ON only if:
 - TRANS RANGE SW displays DRIVE 4 or DRIVE 3.
 - TRANS OUTPUT SPD must be greater than approximately 1800 RPM.
 - TCC BRAKE SWITCH displays CLOSED.
 - THROTTLE ANGLE must be at least approximately 2%.
 - THROTTLE ANGLE must remain steady.
 - TRANS FLUID TEMP must be above 20°C.
 - ENG COOL TEMP must be above 20°C.
 - TCC SLIP SPD is less than -60 RPM.
 - If CRUISE ENGAGED displays YES, then TCC uses a shift pattern that requires a higher TRANS OUTPUT SPD.
- CTR. FDBK TCC should always display OK.
 - If FAULT is displayed, then the TCC solenoid should be checked.
- TCC SLIP SPD should be +/-30 RPM if TCC is applied.

TCC DOES NOT RELEASE

- The Torque Converter Clutch is fed by 2nd gear fluid.
 - The earliest TCC can apply is 2nd gear.
- If HOT MODE displays YES, the TCC is engaged in 4th gear, 3rd gear and 2nd gear, except for the following conditions:
 - TCC BRAKE SWITCH displays CLOSED.
 - THROTTLE ANGLE must be at least approximately 2%.
 - A DTC is current.
- CTR. FDBK TCC should always display OK.
 - If FAULT is displayed, then the TCC solenoid should be checked.

RH0044-4L80-E

Figure 44 Example of Tech 1 Information (TCC System)

3-2 DETENT DOWNSHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	3RD GEAR	2ND GEAR
ENGINE SPEED	1414 RPM	2430 RPM
TRANS OUTPUT SPD	1059 RPM	1315 RPM
TRANS FLUID TEMP	75°C	75°C
THROTTLE ANGLE	10 %	100 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	3	2
1-2 SOL 2-3 SOL	OFF ON	OFF OFF
** CTR FDBK 1/2 2/3	OK OK	OK OK
† CTR FDBK 1/2 2/3	OFF ON	OFF OFF
**† KICKDOWN ENABLED	NO	YES
TRANS GEAR RATIO	1.0	1.48

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

* THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E

NO 3-2 DOWNSHIFT

- KICKDOWN ENABLED displays YES when THROTTLE ANGLE is greater than 70%.
- If COMMANDED GEAR changes from 2 to 3 and the vehicle does not shift (TRANS GEAR RATIO should equal 1.00 in third gear).
 - ** CTR FDBK 1/2 2/3 should display OK.
 - If one displays FAULT, that shift solenoid should be checked.
 - † CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-17A).
- TRANS GEAR RATIO should increase from 1.00 to 1.48.

RH0045-4L80-E

Figure 45 Example of Tech 1 Information (3-2 Detent Downshifts)

4-2 DETENT DOWNSHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	4TH GEAR	2ND GEAR
ENGINE SPEED	919 RPM	2788 RPM
TRANS OUTPUT SPD	1390 RPM	1555 RPM
TRANS FLUID TEMP	79°C	79°C
THROTTLE ANGLE	0 %	100 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	2
1-2 SOL 2-3 SOL	ON ON	OFF OFF
** CTR FDBK 1/2 2/3	OK OK	OK OK
† CTR FDBK 1/2 2/3	ON ON	OFF OFF
**† KICKDOWN ENABLED	NO	YES
TRANS GEAR RATIO	.66	1.48

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

* THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

4-2 DOWNSHIFT INFORMATION

- KICKDOWN ENABLED displays YES when THROTTLE ANGLE is greater than 70%.
- TRANS GEAR RATIO should increase from (.55-1.0) to 1.48.
- TRANS GEAR RATIO displays between .55 to 1.0 in 4th gear if the TCC is not on. When TCC applies gear ratio should equal about .75. This is caused by the forward clutch overrunning in 4th gear.
- If COMMANDED GEAR changes from 4 to 3 to 2 and the vehicle does not shift (TRANS GEAR RATIO should equal .49 in second gear).
 - ** CTR FDBK 1/2 2/3 should display OK.
 - If one displays FAULT, that shift solenoid should be checked.
 - † CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-17A).

Figure 46 Example of Tech 1 Information (4-2 Detent Downshifts)

4-3 DETENT DOWNSHIFTS**TECH 1 INFORMATION****1994 MODEL YEAR 4L80-E TRANSMISSION****VEHICLE:** C/K and P-TRUCKS, G-VAN**POWERTRAIN:** 6.5L 4L80-E, 4.3L 4L80-E

5.7L 4L80-E, 7.4L 4L80-E

	4TH GEAR	3RD GEAR
ENGINE SPEED	1434 RPM	2240 RPM
TRANS OUTPUT SPD	1563 RPM	1688 RPM
TRANS FLUID TEMP	89°C	89°C
THROTTLE ANGLE	15 %	54 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	3
1-2-SOL 2-3 SOL	ON ON	OFF ON
** CTR FDBK 1/2 2/3	OK OK	OK OK
† CTR FDBK 1/2 2/3	ON ON	OFF ON
**† KICKDOWN ENABLED	NO	YES
TRANS GEAR RATIO	1.0	1.0

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

* THE ABOVE DATA IS CONTAINED ON ALL APPLICATIONS UNLESS NOTED BELOW:

** CONTAINED ONLY ON THE 6.5L L56 AND L65 4L80-E PCM-E

† CONTAINED ONLY ON THE 4.3L/5.7L/7.4L 4L80-E PCM-6

‡ CONTAINED ONLY ON THE 6.5L L57 4L80-E TCM

4-3 DOWNSHIFT

- KICKDOWN ENABLED displays YES when THROTTLE ANGLE is greater than 70%.
- TRANS GEAR RATIO will increase from .75 to 1.00.
- If COMMANDED GEAR changes from 4 to 3 and the vehicle does not shift (TRANS GEAR RATIO should equal 1.00 in third gear).
 - ** CTR FDBK 1/2 2/3 should display OK.
 - If one displays FAULT, that shift solenoid should be checked.
 - † CTR FDBK 1/2 2/3 should be identical to 1-2 SOL 2-3 SOL.
 - If one does not match, that shift solenoid should be checked.
 - Refer to Diagnosis Charts (7A-17A).
- TRANS GEAR RATIO displays between .55 to 1.0 in 4th gear if the TCC is not on. When TCC applies gear ratio should equal about .75. This is caused by the forward clutch overrunning in 4th gear.

Figure 47 Example of Tech 1 Information (4-3 Detent Downshifts)

MANUAL DOWNSHIFTS**TECH 1 INFORMATION**

1994 MODEL YEAR 4L80-E TRANSMISSION
VEHICLE: C/K and P-TRUCKS, G-VAN
POWERTRAIN: 6.5L 4L80-E, 4.3L 4L80-E
5.7L 4L80-E, 7.4L 4L80-E

	DRIVE 4	DRIVE 3	DRIVE 2	DRIVE 1
ENGINE SPEED	1650 RPM	1477 RPM	2312 RPM	2451 RPM
TRANS OUTPUT SPD	2200 RPM	2070 RPM	1642 RPM	1038 RPM
TRANS RANGE SW	DRIVE 4	DRIVE 3	DRIVE 2	LOW
COMMANDED GEAR	4	3	2	1
THROTTLE ANGLE	0 %	0 %	0 %	0 %

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

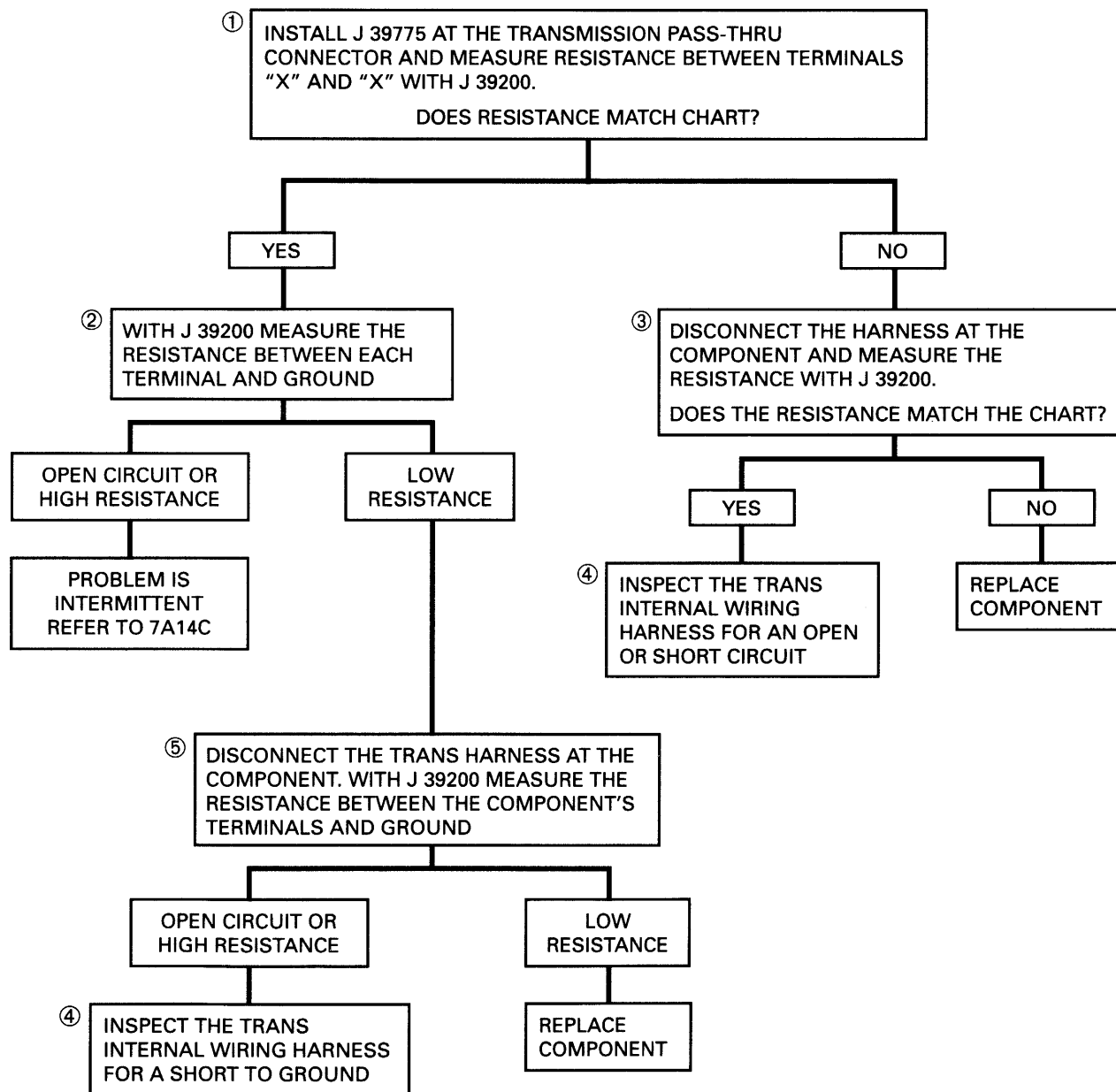
- ENGINE SPEED should increase as lower gears are selected.
- TRANS RANGE SW should match the selected gear range.
 - In LOW the transmission may upshift to 2nd gear at high ENGINE SPEED and THROTTLE ANGLE. (Some applications only)
 - In DRIVE 2 the transmission will not upshift to 3rd or 4th gears.
 - In DRIVE 3 the transmission will not upshift to 4th gear but TCC will normally apply and COMMANDED GEAR may display fourth gear.

RH0048-4L80-E

Figure 48 Example of Tech 1 Information (Manual Downshifts)

NOTE: This procedure cannot be used on the pressure switch assembly. See figure 18.

4L80-E TRANSMISSION INTERNAL WIRING HARNESS CHECK



① This test measures the resistance of the component at the transmission pass-thru connector.

② This test checks for a short to ground in the internal wiring harness or component.

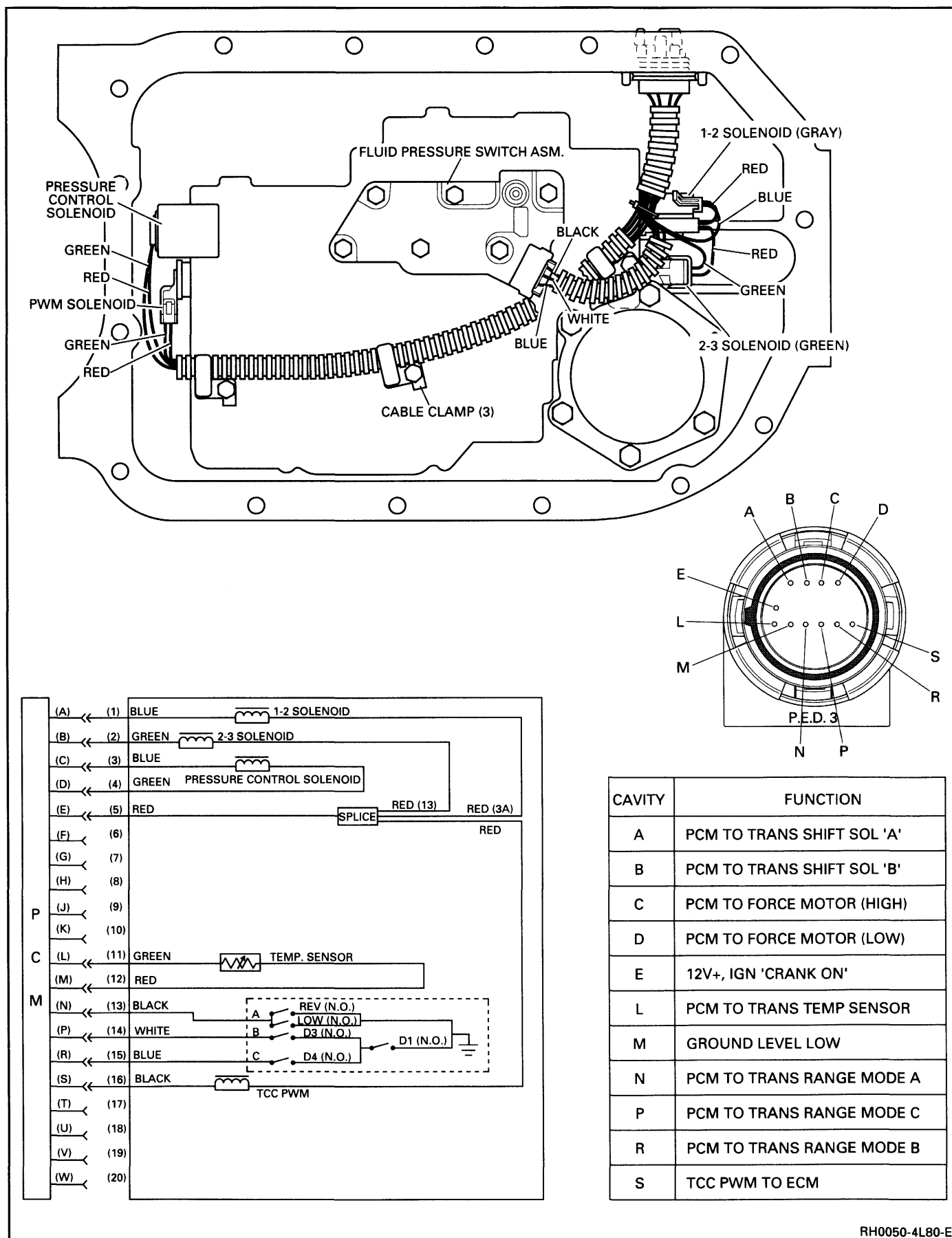
③ This test measures the resistance of the component.

④ Check the internal wiring harness for continuity, pinched wires and corrosion.

⑤ This test checks for a short to ground in the component (cannot be used on TCC solenoid).

RH0049-4L80-E

Figure 49 Internal Wiring Harness Check



RH0050-4L80-E

Figure 50 Wiring Diagram

4L80-E COMPONENT RESISTANCE CHART

COMPONENT	WIRE COLOR	PASS-THRU PIN	RESISTANCE @ 20°C	CKT #
1-2 SHIFT SOLENOID	RED	E *	20 - 40 Ohms	1149A
	BLUE	A		1222
2-3 SHIFT SOLENOID	RED	E *	20 - 40 Ohms	1149B
	GRN	B		1223
PRESSURE CONTROL SOLENOID	BLUE	C	3.5 - 8 Ohms	1228
	GRN	D		1229
TCC SOLENOID	RED	E *	20 - 40 Ohms	1149C
	BLACK	S		1350

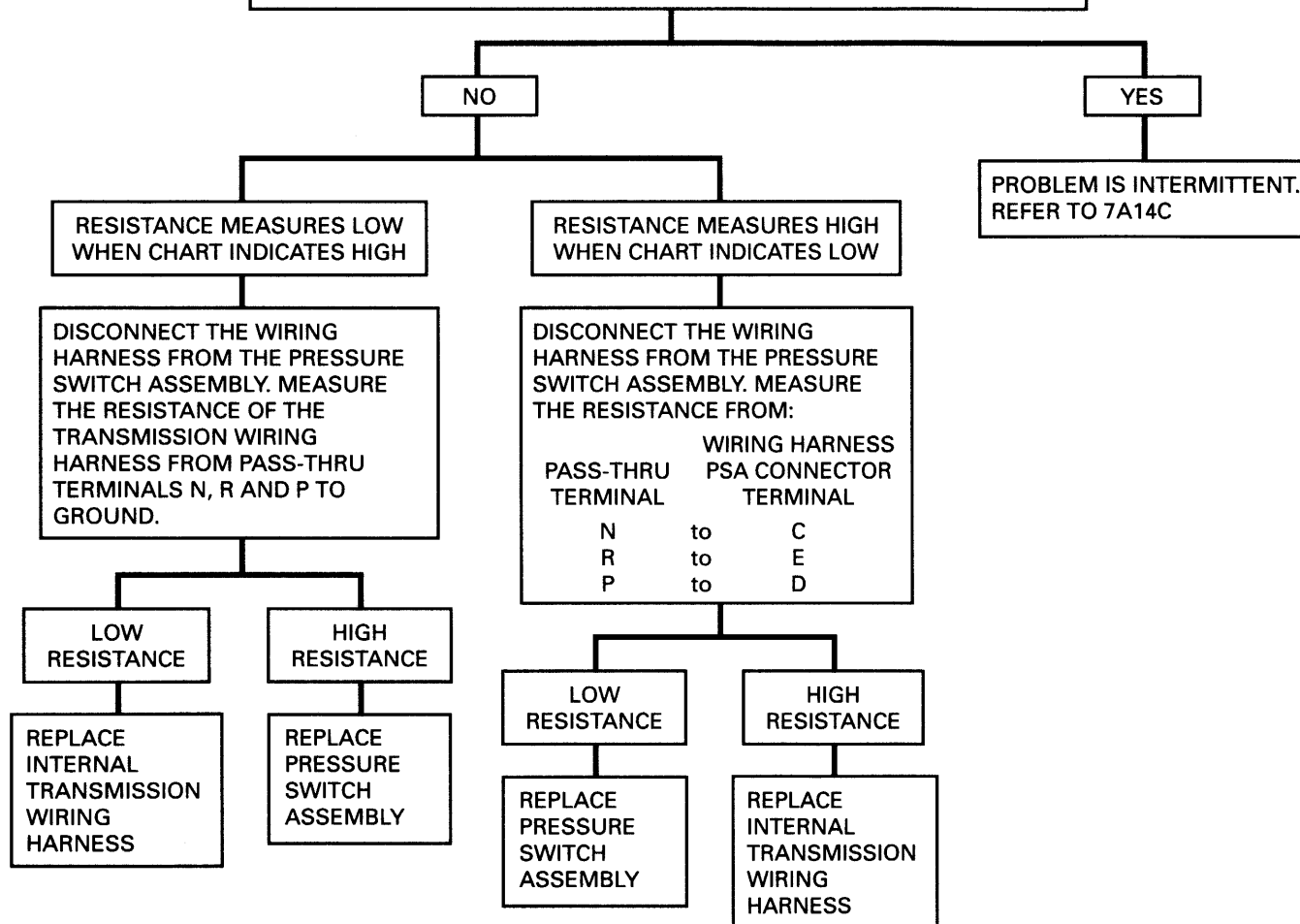
* Spliced internally to Pin E.

RH0051-4L80-E

Figure 51 Component Resistance Chart

4L80-E TRANSMISSION PRESSURE SWITCH ASSEMBLY RESISTANCE CHECK

INSTALL J 39775 AT THE TRANSMISSION PASS-THRU CONNECTOR. WITH ENGINE RUNNING, MEASURE RESISTANCE BETWEEN EACH TERMINAL (N, R AND P) AND GROUND WITH J 39200. (SEE CHART BELOW). MOVE THE GEAR SELECTOR THROUGH THE DIFFERENT GEAR RANGES.



Pressure Switch Assembly (PSA) Resistance Chart

Gear Selector Position	Range		
	A	B	C
PARK	H	L	H
REVERSE	L	L	H
NEUTRAL	H	L	H
D4	H	L	L
D3	H	H	L
D2	H	H	H
D1	L	H	H

When range "X" is measured for resistance to ground,
 H = High resistance (over 100 Ohms) - open circuit
 L = Low resistance (under 200 Ohms) - grounded circuit

IMPORTANT:

Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple transmission Diagnostic Trouble Codes will set. Be sure to clear these codes when finished with this procedure.

RH0052-4L80-E

Figure 52 Pressure Switch Assembly Resistance Check

FLUID LEAK DIAGNOSIS AND REPAIR

The cause of most external leaks can generally be located and repaired with the transmission in the vehicle.

METHODS FOR LOCATING LEAKS

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut the engine off and look for fluid spots on the paper.
6. Make necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder (foot powder) to the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Shut the engine off.
5. Inspect the suspected leak area and trace the leak path through the powder to find the source.
6. Make necessary repairs.

Dye and Black Light Method

1. Follow the manufacturer's recommendation for the amount of dye to be used.
2. Find the leak with a black light.
3. Make necessary repairs.

REPAIRING THE LEAK

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check to be sure that the following conditions are correct as they may cause a leak.

Gaskets

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Improperly torqued fasteners or dirty/damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs, or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant used (where applicable).
- Porosity.

Seals

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Damaged seal bore (scratched, burred or nicked).

- Damaged or worn seal.
- Improper installation.
- Cracks in component.
- Manual or output shaft surface scratched, nicked, or missing.
- Loose or worn bearing causing excess seal wear.

POSSIBLE POINTS OF OIL LEAKS

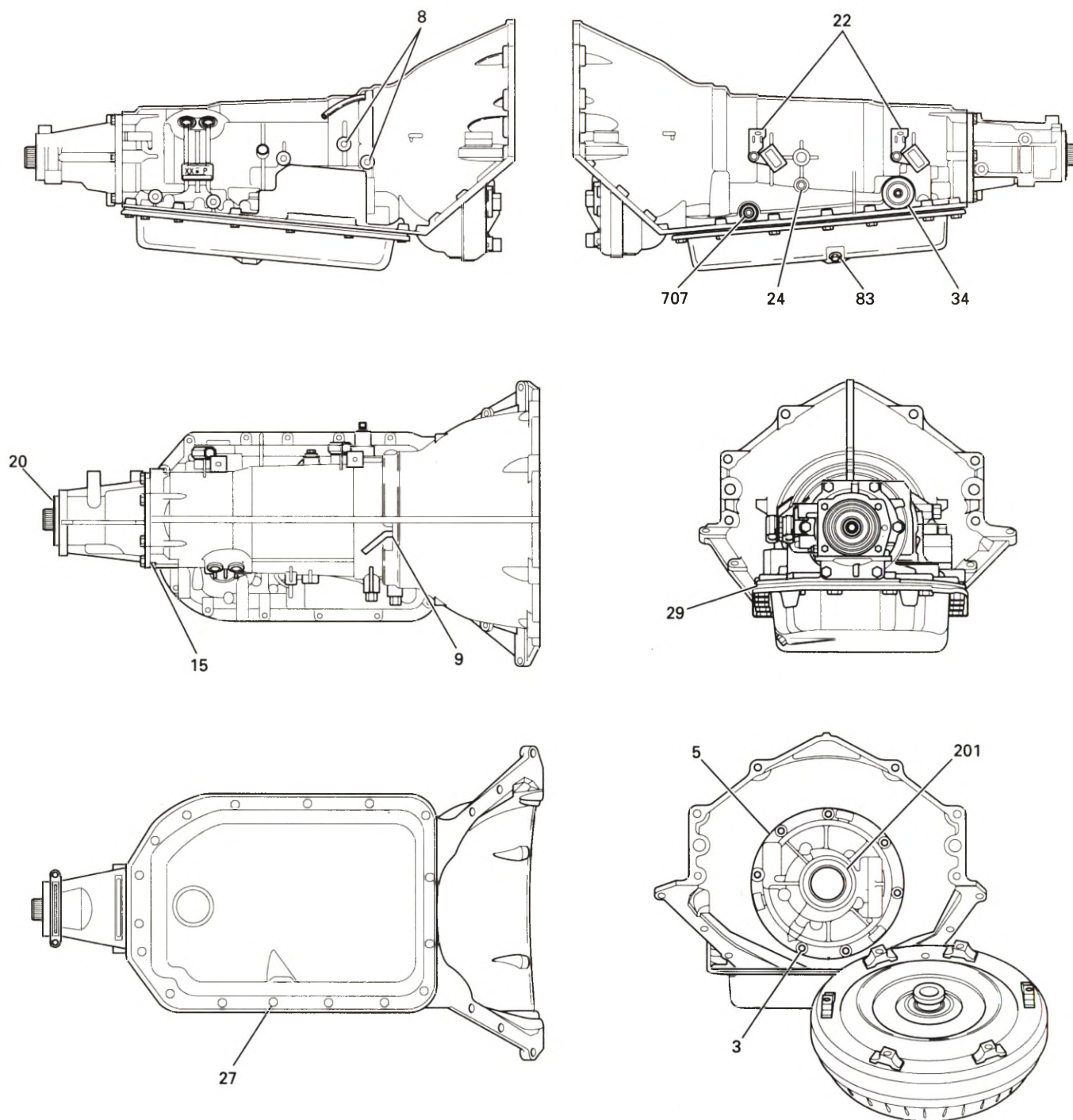
1. Transmission and transmission oil pan:
 - Attaching bolts not torqued correctly.
 - Improperly installed or damaged gasket.
 - Oil pan or mounting face not flat.
2. Case Leak:
 - Filler tube multi-lip seal damaged or missing.
 - Filler tube bracket misaligned.
 - Speed sensor seal damaged.
 - Manual shaft seal damaged.
 - Oil cooler connector fittings loose or damaged.
 - Propeller shaft oil seal worn or damaged.
 - Line pressure pipe plug loose.
 - Porous casting.
3. Leak at converter end:
 - Converter seal damaged.
 - Seal lip cut (check converter hub for damage).
 - Bushing moved forward and damaged.
 - Garter spring missing from seal.
 - Converter leak in weld area.
 - Porous casting (case or pump).
4. Fluid comes out vent pipe or fill tube:
 - Overfilled.
 - Water or coolant in fluid (fluid will appear milky).
 - Case porous.
 - Incorrect fluid level indicator.
 - Plugged vent.
 - Drain back holes plugged.
 - The alignment of the oil pump to case gasket (if equipped).

CASE POROSITY REPAIR

1. Clean the leak area with solvent and air dry.

CAUTION: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Mix a sufficient amount of epoxy adhesive (GM P/N 1052533 or equivalent) following the manufacturer's recommendations.
3. While the transmission case is hot, apply epoxy adhesive with a clean, dry soldering acid brush.
4. Allow the epoxy adhesive to cure for three hours before starting the engine.
5. Repeat fluid leak diagnosis procedures.



- 3 BOLT AND SEAL ASSEMBLY, PUMP TO CASE
- 5 SEAL, OIL PUMP TO CASE
- 8 CONNECTOR, INVERTED FLARED TUBE
- 9 PIPE, VENT
- 15 SEAL, EXTENSION TO CASE
- 20 HELIX SEAL ASSEMBLY, CASE EXTENSION
- 22 SENSOR ASM, A/TRANS. INPUT SPD. AND VEH. SPD.

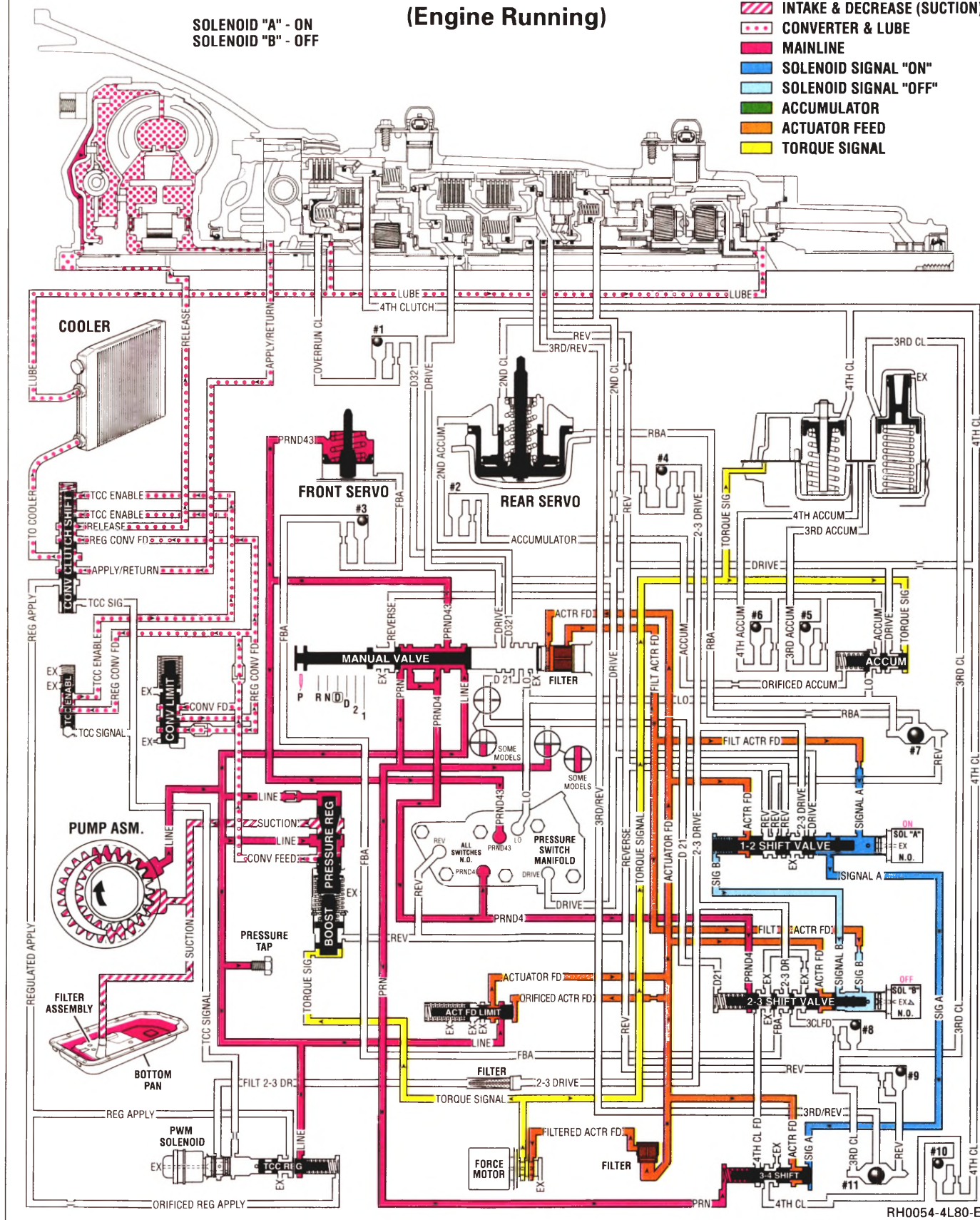
- 24 PLUG, OIL TEST HOLE (HEX HD 1/8 PIPE)
- 27 BOLT, HEX FLANGE HD (PAN TO CASE)
- 29 SEAL, TRANS. OIL PAN
- 34 HARNESS ASSEMBLY, ELECTRICAL WIRING
- 83 WASHER, TYPE A FLAT GASKET
- 201 HELIX SEAL ASSEMBLY, PUMP BODY
- 707 SEAL ASSEMBLY, MANUAL SHIFT SHAFT

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Figure 53 Leak Inspection Points

PARK OR NEUTRAL (Engine Running)

- PRESSURES**
- ▨ INTAKE & DECREASE (SUCTION)
 - ▨ CONVERTER & LUBE
 - ▨ MAINLINE
 - ▨ SOLENOID SIGNAL "ON"
 - ▨ SOLENOID SIGNAL "OFF"
 - ▨ ACCUMULATOR
 - ▨ ACTUATOR FEED
 - ▨ TORQUE SIGNAL



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Figure 54 Park or Neutral Engine Running

PARK OR NEUTRAL (Engine Running)

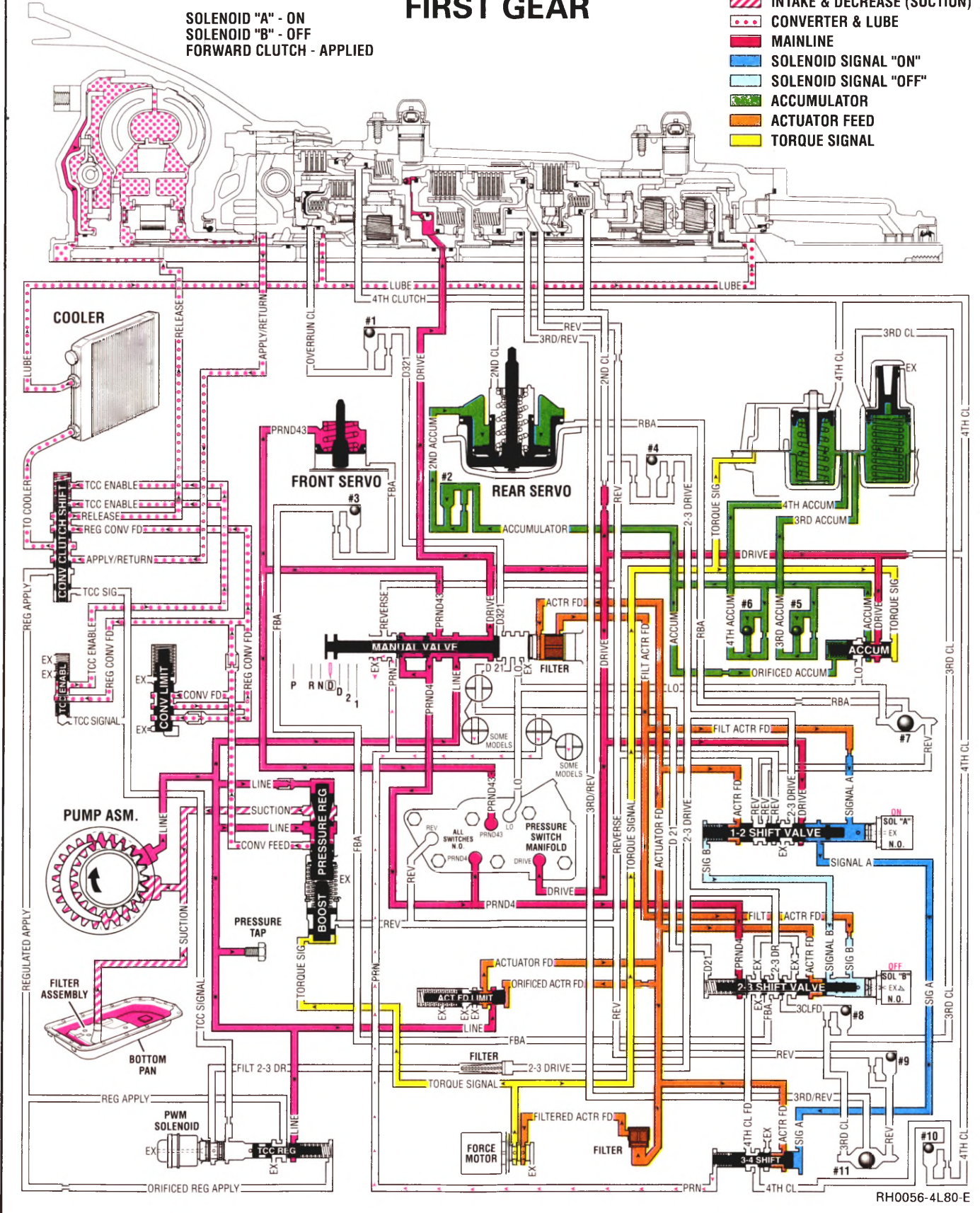
When the vehicle is started, the oil pump generates fluid flow from the transmission sump through the filter into the pump. Filtered transmission fluid is directed to the pressure regulator valve.

- **Pressure Regulator Valve:** The pressure regulator valve regulates operating line pressure according to various driving conditions. Converter feed pressure is directed to the torque converter hydraulic system and regulated line pressure is directed to the torque converter clutch regulated apply valve, actuator feed limit valve and manual valve.
- **Torque Converter Clutch Regulated Apply Valve (TCCRAV):** Line pressure is supplied to the TCCRAV to be utilized in other gear ranges.
- **Actuator Feed Limit Valve:** Regulates actuator feed pressure to the 1-2, 2-3, 3-4 shift valves the pressure control solenoid and 1-2 and 2-3 solenoids.
- **Manual Valve:** Line pressure from the pressure regulator valve is supplied to the manual valve to be utilized in other gear ranges. In Park range, line pressure is directed as PRND43, PRND4 and PRN fluid pressure.
- **Transmission Fluid Pressure Switch Assembly:** PRND4 and PRND43 fluid pressures from the manual valve are directed to their respective switches on the Transmission Fluid Pressure Switch ASM, this sends a signal to the Powertrain Control Module (PCM) that the transmission is in Park range.
- **1-2 Solenoid:** Energized, signal "A" fluid pressure forces the 1-2 shift valve to the extreme left against spring force.
- **2-3 Solenoid:** De-energized, exhausting signal "B" fluid through the solenoid. Spring force holds the 2-3 shift valve to the extreme right.
- **1-2 Shift Valve:** Held to the left against spring force by signal "A" fluid pressure.
- **2-3 Shift Valve:** Held to the extreme right by spring force. This blocks the PRND4 fluid pressure at the 2-3 shift valve.
- **3-4 Shift Valve:** Held to the extreme right by spring force and PRN fluid pressure.
- **Front Servo:** PRND43 fluid pressure from the manual valve is directed to the front servo which assists the spring force to hold the front servo off.

OVERDRIVE RANGE FIRST GEAR

SOLENOID "A" - ON
SOLENOID "B" - OFF
FORWARD CLUTCH - APPLIED

- PRESSURES**
- ▨ INTAKE & DECREASE (SUCTION)
 - ▨ CONVERTER & LUBE
 - ▨ MAINLINE
 - ▨ SOLENOID SIGNAL "ON"
 - ▨ SOLENOID SIGNAL "OFF"
 - ▨ ACCUMULATOR
 - ▨ ACTUATOR FEED
 - ▨ TORQUE SIGNAL



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Figure 56 D4 First Gear

OVERDRIVE RANGE FIRST GEAR

When the gear selector lever is moved to the Overdrive position, the manual valve is repositioned to allow line pressure to flow in it's respective circuits.

- **Manual Valve:** In the Overdrive range first gear, line pressure from the pressure regulator valve is directed as PRND4, PRND43 and Drive fluid pressures. The PRND4 fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and to the 2-3 shift valve, the PRND43 fluid is directed to the Transmission Fluid Pressure Switch ASM and to the front servo, and the Drive fluid is directed to the Transmission Fluid Pressure Switch ASM forward clutch, 1-2 shift valve and accumulator valve.
- **Transmission Fluid Pressure Switch ASM:** Drive, PRND4 and PRND43 fluid pressures from the manual valve are directed to the DR, PRND4 and PRND43 switches on the Transmission Fluid Pressure Switch ASM, this sends a signal to the Powertrain Control Module (PCM) that the transmission is in Overdrive range.
- **1-2 Solenoid:** Energized, signal "A" fluid pressure forces the 1-2 shift valve to the extreme left against spring force.
- **2-3 Solenoid:** De-energized, exhausting signal "B" fluid through the solenoid. Spring force holds the 2-3 shift valve to the extreme right.
- **1-2 Shift Valve:** Drive fluid pressure from the manual valve is held at the 1-2 shift valve to be utilized in other gear ranges.
- **2-3 Shift Valve:** PRND4 fluid pressure from the manual valve is held at the 2-3 shift valve to be utilized in other gear ranges.
- **3-4 Shift Valve:** Held to the extreme left by signal "A" pressure. PRN fluid pressure is blocked by the manual valve.
- **Forward Clutch:** Drive fluid pressure from the manual valve is directed through the case, pump housing and the turbine shaft into the forward clutch housing which applies the forward clutch, shifting the transmission into first gear.

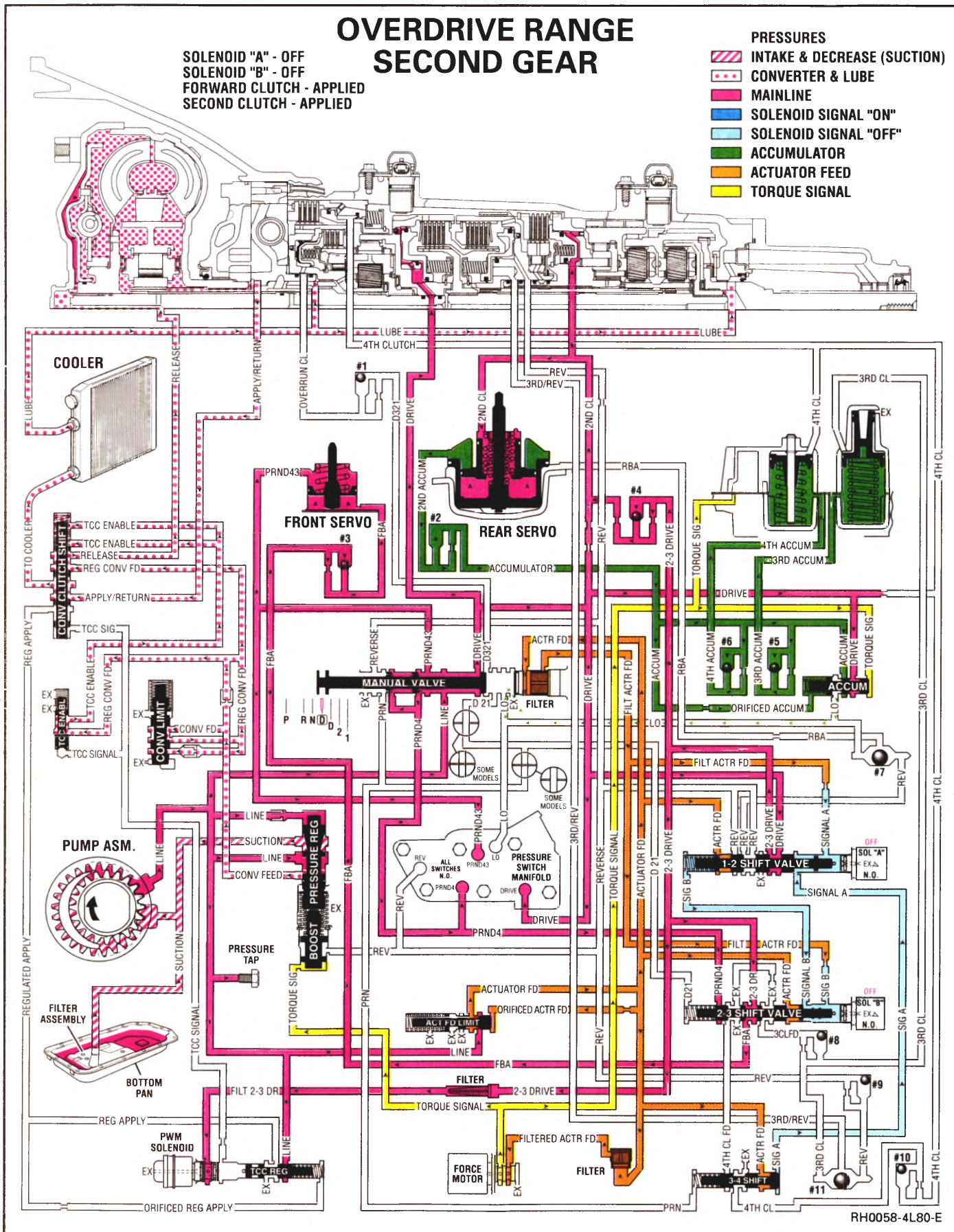


Figure 58 D4 Second Gear

OVERDRIVE RANGE SECOND GEAR

To obtain second gear, the Powertrain Control Module (PCM) receives input signals from the Vehicle Speed Sensor (VSS), Throttle Position Sensor (TP Sensor) and other engine sensors, to determine when to “de-energize” solenoid “A”.

- **Manual Valve:** In the Overdrive range second gear, line pressure from the pressure regulator valve is directed as PRND4, PRND43 and Drive fluid pressures. The PRND4 fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and to the 2-3 shift valve, the PRND43 fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and to the front servo, and the Drive fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and forward clutch.
- **Transmission Fluid Pressure Switch ASM:** Drive, PRND and PRND43 fluid pressures from the manual valve are directed to the DR, PRND4 and PRND43 switches on the Transmission Fluid Pressure Switch ASM, this sends a signal to the PCM that the transmission is in Overdrive range.
- **1-2 Solenoid:** De-energized, exhausting signal “A” fluid through the solenoid allowing spring force to move the 1-2 shift valve to the extreme right.
- **2-3 Solenoid:** De-energized, exhausting signal “B” fluid through the solenoid, thus the 2-3 shift valve is held to the extreme right by spring force.
- **1-2 Shift Valve:** Is held to the extreme right by spring force. Drive fluid pressure from the manual valve is changed into 2-3 drive fluid pressure at the 1-2 shift valve, this pressure is directed to the 2-3 shift valve, PWM solenoid and the intermediate (second) clutch.
- **2-3 Shift Valve:** Is held to the extreme right by spring force. 2-3 drive fluid pressure from the 1-2 shift valve is changed into Front Band Apply (FBA) and directed to the front servo. PRND4 fluid pressure from the manual valve is held at the 2-3 shift valve to be utilized in other gear ranges.
- **3-4 Shift Valve:** Held to the extreme right by spring force.
- **Forward Clutch:** Is applied by Drive fluid pressure from the manual valve.
- **Intermediate (Second) Clutch:** Is applied by 2nd fluid pressure from the 1-2 shift valve. 2-3 drive fluid pressure from the 1-2 shift valve seats the #4 checkball and causes the fluid to flow through two orifices (which then becomes 2nd apply fluid pressure) into the center support which applies the intermediate (second) clutch.

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Figure 59 D4 Second Gear – Legend

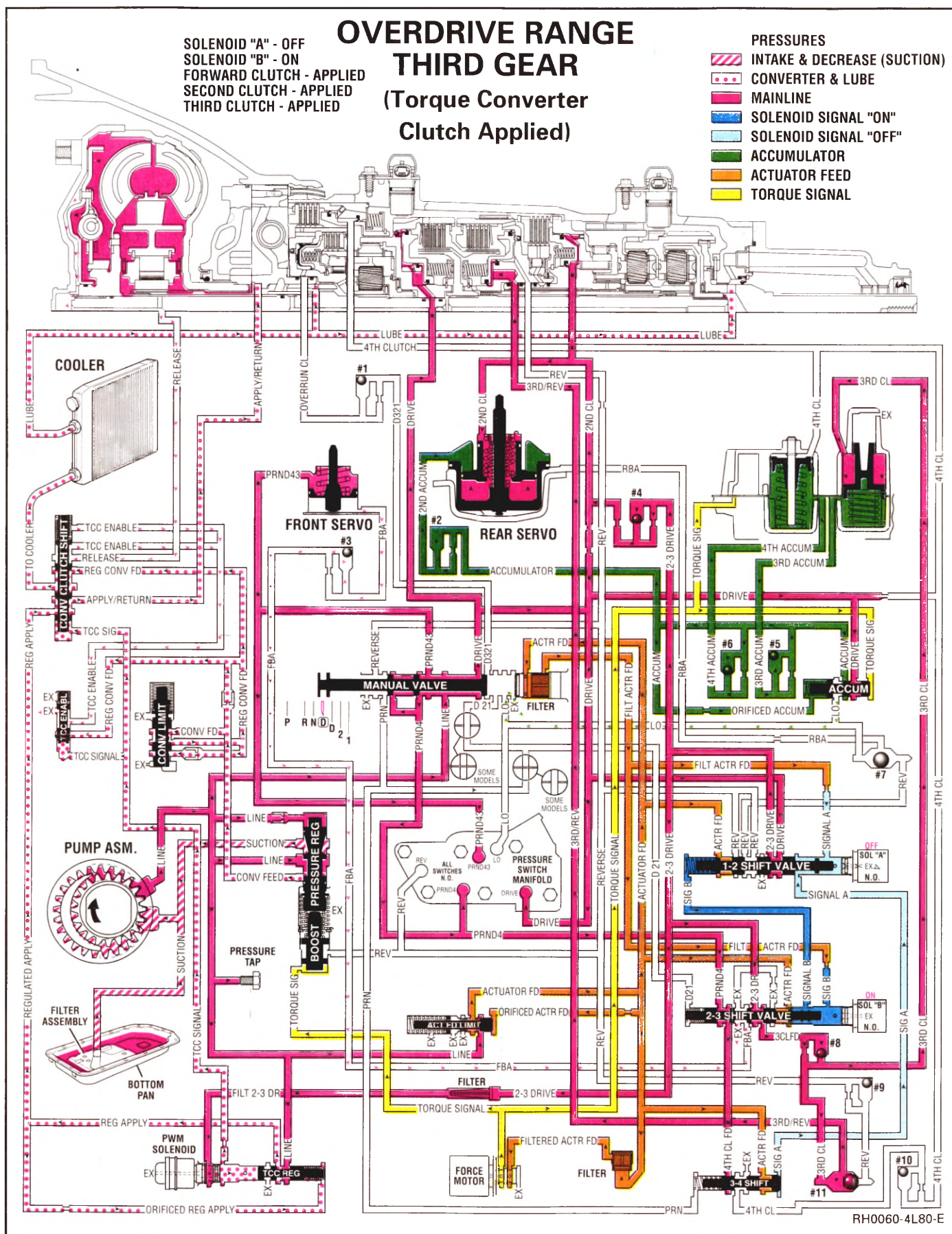


Figure 60 D4 Third Gear

OVERDRIVE RANGE THIRD GEAR (Torque Converter Clutch Applied)

To obtain third gear, the Powertrain Control Module (PCM) receives input signals from the Vehicle Speed Sensor (VSS), Throttle Position Sensor (TP Sensor) and other engine sensors, to determine when to "energize" solenoid "B".

- **Manual Valve:** In the Overdrive range third gear, line pressure from the pressure regulator valve is directed as PRND4, PRND43 and Drive fluid pressures. The PRND4 fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and to the 2-3 shift valve, the PRND43 fluid is directed to the Transmission Fluid Pressure Switch ASM and to the front servo, and the Drive fluid is directed to the Transmission Fluid Pressure Switch ASM and forward clutch.
- **Transmission Fluid Pressure Switch ASM:** Drive, PRND4 and PRND43 fluid pressures from the manual valve are directed to the DR, PRND4 and PRND43 switches on the Transmission Fluid Pressure Switch ASM, this sends a signal to the PCM that the transmission is in Overdrive range.
- **1-2 Solenoid:** De-energized, exhausting signal "A" pressure through the solenoid allowing spring force to move the 3-4 shift valve to the extreme right.
- **2-3 Solenoid:** Energized, the signal "B" pressure with spring force holds the 1-2 shift valve to the extreme right.
- **1-2 Shift Valve:** Held to the extreme right by signal "B" fluid pressure and spring force. Drive fluid pressure from the manual valve is changed into 2-3 drive fluid pressure at the 1-2 shift valve, this pressure is directed to the 2-3 shift valve, Pulse Width Modulated (PWM) solenoid and the intermediate (second) clutch.
- **2-3 Shift Valve:** PRND4 fluid pressure from the manual valve is directed through the 2-3 shift valve (which turns into 4TH CL FD fluid pressure) to the 3-4 shift valve. 2-3 DR fluid pressure from the 1-2 shift valve is changed into 3RD CL FD fluid pressure at the 2-3 shift valve, this fluid is directed to the #8 checkball which seats and forces the fluid through an orifice (where it becomes 3RD CL fluid pressure) and is directed to the third accumulator. 3RD CL FD fluid pressure is also directed to the #11 checkball which seats and forces the fluid through an orifice (which changes into 3RD/REV fluid pressure) and to the direct clutch.
- **3-4 Shift Valve:** 4TH CL FD fluid pressure is blocked at the 3-4 shift valve to be utilized in Overdrive range fourth gear.
- **Forward Clutch:** Is applied by Drive fluid pressure from the manual valve.
- **Intermediate (Second) Clutch:** Is applied by 2ND fluid pressure from the 1-2 shift valve. 2-3 drive fluid pressure from the 1-2 shift valve seats the #4 checkball in the case and causes the fluid to flow through two orifices (which then becomes 2ND apply fluid pressure) into the center support which applies the intermediate clutch.
- **Direct Clutch:** Third/reverse pressure from the #11 checkball flows through the case and the center support to apply the inner piston area of the direct clutch.
- **Third Clutch Accumulator:** 3RD CL fluid pressure is also applied to the third clutch accumulator which is encased in the accumulator housing. This moves the third accumulator piston against the spring force and accumulator fluid pressure.
- **Pulse Width Modulated (PWM) Solenoid:** When energized by the PCM signal pressure shifts the converter clutch shift valve, thus the Torque Converter Clutch (TCC) is applied. The signal pressure also acts on the torque converter clutch regulator valve which regulates output pressure to control the apply and release of the TCC.

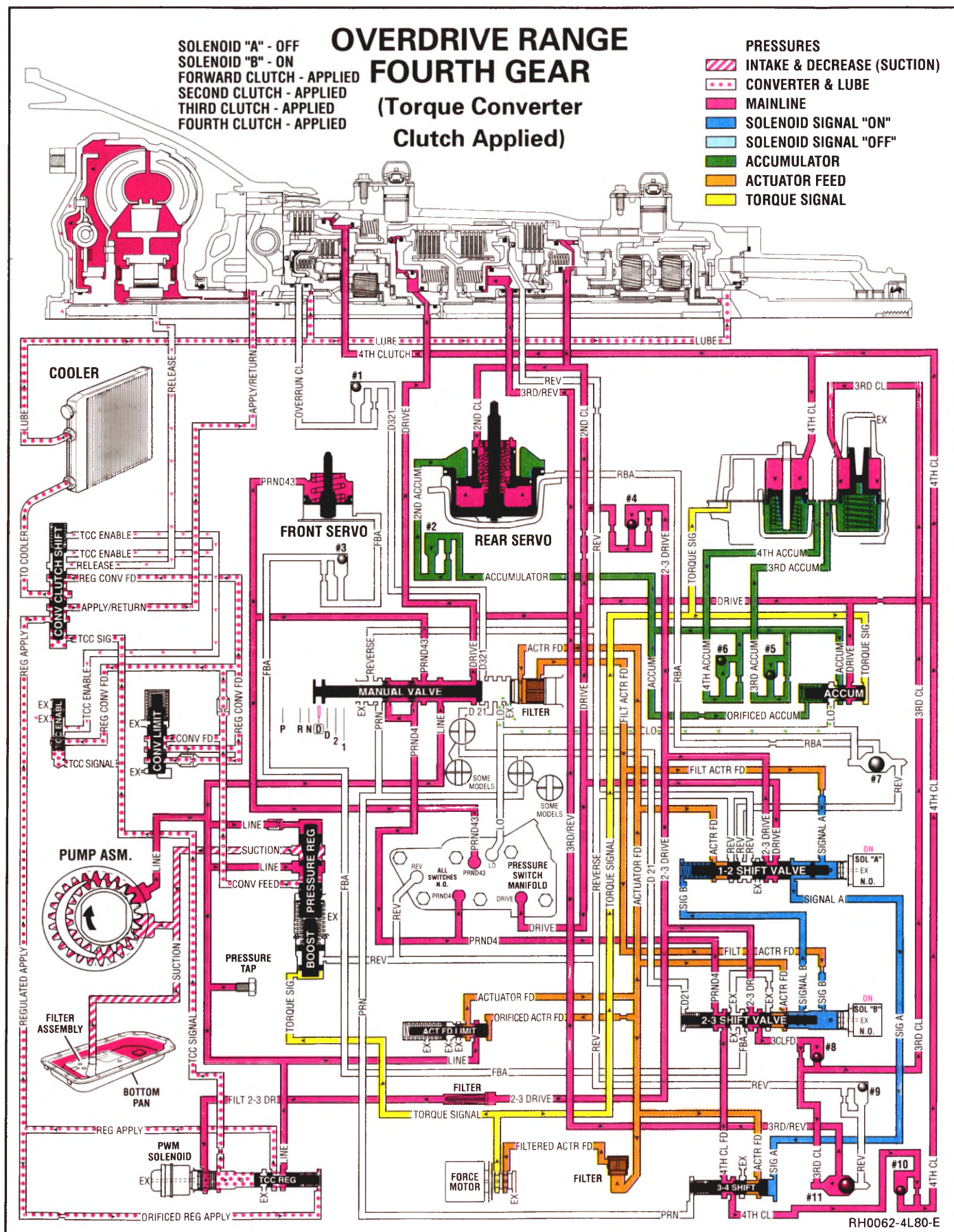


Figure 62 D4 Fourth Gear

OVERDRIVE RANGE FOURTH GEAR (Torque Converter Clutch Applied)

To obtain fourth gear, the Powertrain Control Module (PCM) receives input signals from the Vehicle Speed Sensor (VSS), Throttle Position Sensor (TP Sensor) and other engine sensors, to determine when to "energize" solenoid "A".

- **Manual Valve:** In the Overdrive range fourth gear, line pressure from the pressure regulator valve is turned into PRND4, PRND43 and Drive fluid pressures. The PRND4 fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and to the 2-3 shift valve, the PRND43 fluid is directed to the Transmission Fluid Pressure Switch ASM and to the front servo, and the Drive fluid is directed to the Transmission Fluid Pressure Switch ASM and forward clutch.
- **Transmission Fluid Pressure Switch ASM:** Drive, PRND4 and PRND43 fluid pressures from the manual valve are directed to the DR, PRND4 and PRND43 switches on the Transmission Fluid Pressure Switch ASM, this sends a signal to the PCM that the transmission is in Overdrive range.
- **1-2 Solenoid:** Energized, the signal "A" pressure forces the 3-4 shift valve against the spring force to move the 3-4 shift valve to the extreme left.
- **2-3 Solenoid:** Energized, the signal "B" fluid pressure with spring force holds the 1-2 shift valve to the extreme right.
- **1-2 Shift Valve:** Held to the extreme right by signal "B" fluid pressure and spring force. Drive fluid pressure from the manual valve is changed into 2-3 drive fluid pressure at the 1-2 shift valve, this pressure is directed to the 2-3 shift valve, Pulse Width Modulated (PWM) solenoid and the intermediate (second) clutch.
- **2-3 Shift Valve:** PRND4 fluid pressure from the manual valve is directed through the 2-3 shift valve (which turns into 4TH CL FD fluid pressure) to the 3-4 shift valve. 2-3 DR fluid pressure from the 1-2 shift valve is changed into 3RD CL FD fluid pressure at the 2-3 shift valve, this fluid is directed to the #8 checkball which seats and forces the fluid through an orifice (where it becomes 3RD CL fluid pressure) and is directed to the third accumulator. 3RD CL FD fluid pressure is also directed to the #11 checkball which seats and forces the fluid through an orifice (which changes into 3RD/REV fluid pressure) and to the direct clutch.
- **3-4 Shift Valve:** Is held to the extreme left by signal "A" fluid pressure. 4TH CL FD from the 2-3 shift valve is changed to 4TH CL fluid pressure at the 3-4 shift valve, 4TH CL fluid is directed to the #10 checkball which seats and forces the fluid through an orifice to apply the fourth clutch and fourth clutch accumulator.
- **Rear Servo:** 2ND fluid pressure is supplied to the rear servo in the same manner as it is to the 2nd clutch. This fluid pressure is directed to the inner piston of the rear servo, thus applying the inner piston.
- **Forward Clutch:** Is applied by Drive fluid pressure from the manual valve.
- **Direct Clutch:** Third/reverse pressure from the #11 checkball flows through the case and into the center support to apply the inner piston area of the direct clutch.
- **Intermediate (Second) Clutch:** Is applied by 2ND fluid pressure from the 1-2 shift valve. 2-3 drive fluid pressure from the 1-2 shift valve seats the #4 checkball in the case and causes the fluid to flow through two orifices (which then becomes 2ND apply fluid pressure) into the center support which applies the intermediate (second) clutch.
- **Fourth Clutch:** Fourth clutch pressure leaves the 3-4 shift valve and seats the #10 checkball, and causes the fluid to flow through an orifice, through the case into the fourth clutch housing which applies the fourth clutch. During the fourth clutch piston stroke, the transmission shifts into fourth gear.
- **Third Clutch Accumulator:** 3RD CL fluid pressure is also applied to the third clutch accumulator which is encased in the accumulator housing. This moves the third accumulator piston against the spring force and accumulator fluid pressure.
- **Fourth Clutch Accumulator:** Fourth clutch pressure is also supplied to the fourth clutch accumulator which is encased in the accumulator housing, this moves the fourth accumulator piston against the spring and accumulator pressure which smooths the 3-4 shift.
- **Pulse Width Modulated (PWM) Solenoid:** When energized by the PCM signal pressure shifts the converter clutch shift valve, thus the Torque Converter Clutch (TCC) is applied. The signal pressure also acts on the torque converter clutch regulator valve which regulates output pressure to control the apply and release of the TCC.

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Figure 63 D4 Fourth Gear – Legend

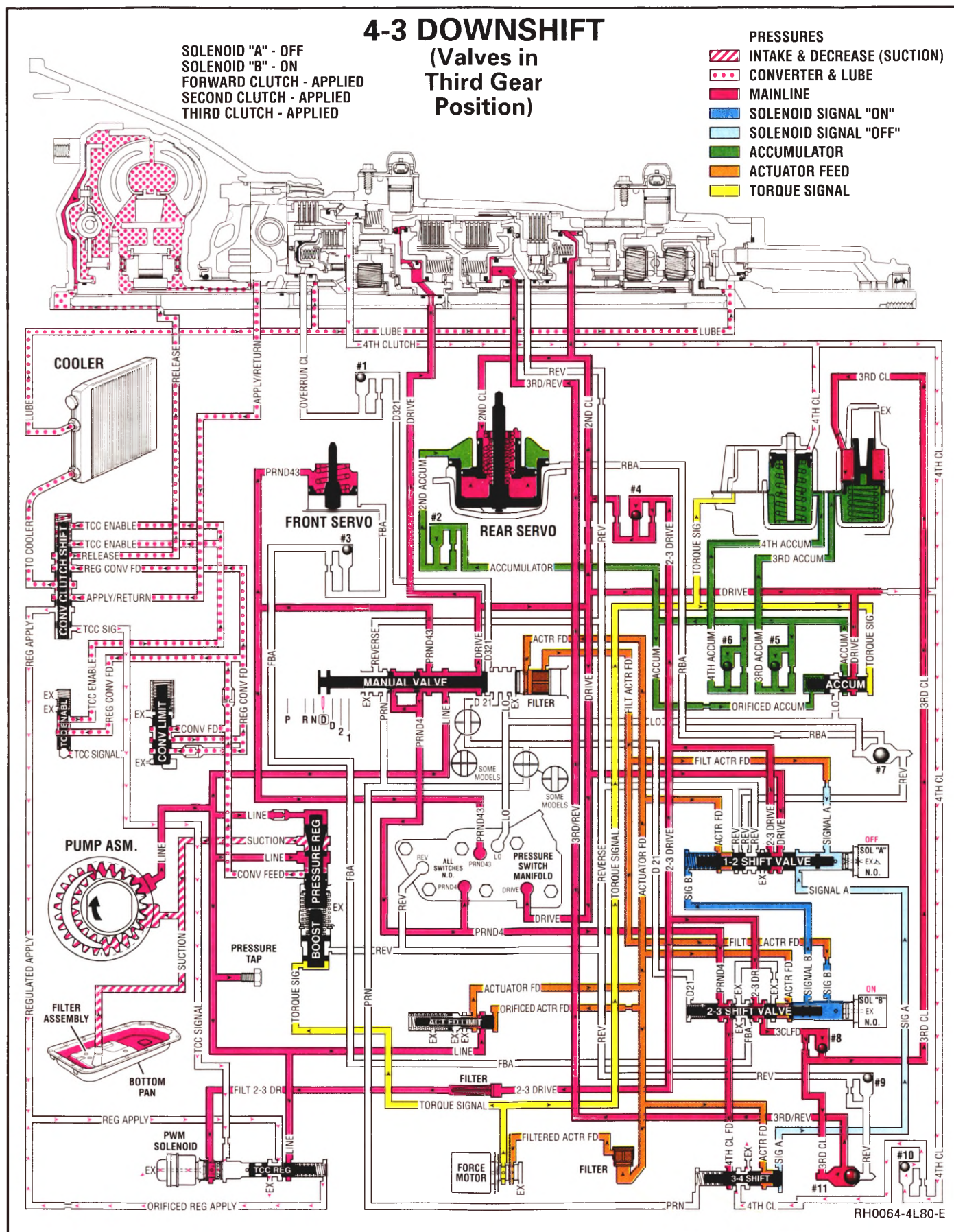


Figure 64 4-3 Downshift

4-3 DOWNSHIFT (Valves in Third Gear Position)

To obtain the 4-3 downshift, the Powertrain Control Module (PCM) receives an input signal from the Throttle Position Sensor (TP Sensor) at increased throttle openings which causes it to de-energize the 1-2 solenoid.

- **1-2 Solenoid:** De-energized, signal "A" fluid exhausts at the solenoid which allows spring force to move the 3-4 shift valve to the extreme right.
- **3-4 Shift Valve:** The fourth clutch apply pressure is shut off and a port is opened at the valve to exhaust fourth clutch fluid leaving the fourth clutch and fourth clutch accumulator. This causes the fourth clutch to release which shifts the transmission into third gear.
- **Fourth Clutch:** Exhausting fourth clutch fluid unseats the #10 checkball which allows for a rapid exhausting of the fourth clutch apply fluid at the 3-4 shift valve.
- **Fourth Clutch Accumulator:** Exhausting fourth clutch accumulator fluid also exhausts through the unseated #10 check valve and exhausts at the 3-4 shift valve.

3-2 DOWNSHIFT (Valves in Second Gear Position)

SOLENOID "A" - OFF
SOLENOID "B" - OFF
FORWARD CLUTCH - APPLIED
SECOND CLUTCH - APPLIED

- PRESSURES**
- INTAKE & DECREASE (SUCTION)
 - CONVERTER & LUBE
 - MAINLINE
 - SOLENOID SIGNAL "ON"
 - SOLENOID SIGNAL "OFF"
 - ACCUMULATOR
 - ACTUATOR FEED
 - TORQUE SIGNAL

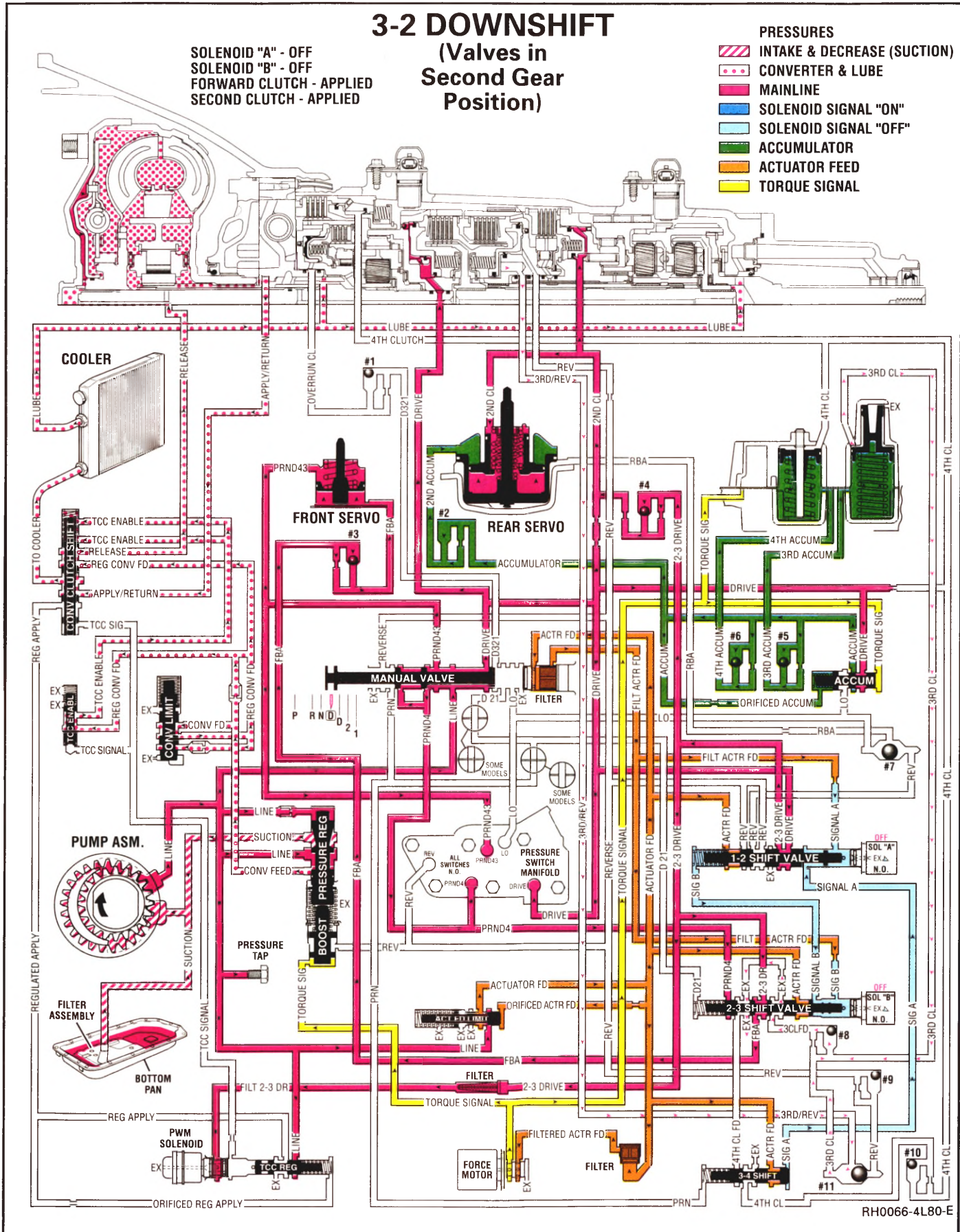


Figure 66 3-2 Downshift

3-2 DOWNSHIFT (Valves in Second Gear Position)

To obtain the 3-2 downshift, the Powertrain Control Module (PCM) receives an input signal from the Throttle Position Sensor (TP Sensor) at increased throttle openings which causes it to de-energize the 1-2 solenoid.

- **1-2 Solenoid:** De-energized, spring force holds 1-2 shift valve to extreme right.
- **2-3 Solenoid:** De-energized, signal "B" pressure exhausts at the solenoid which allows spring force to move the 2-3 shift valve to the extreme right.
- **2-3 Shift Valve:** The third clutch feed pressure from the 2-3 shift valve is shut off and an exhaust port is opened at the 2-3 shift valve to exhaust third clutch fluid leaving the third clutch accumulator. This causes the direct clutch to release which shifts the transmission into second gear.
- **Direct Clutch:** Exhausting third clutch fluid unseats the #8 checkball which allows for a rapid exhausting of the third clutch apply fluid at the 2-3 shift valve.
- **Third Clutch Accumulator:** Exhausting third clutch accumulator fluid also exhausts through the unseated #8 check valve and exhausts at the 2-3 shift valve.

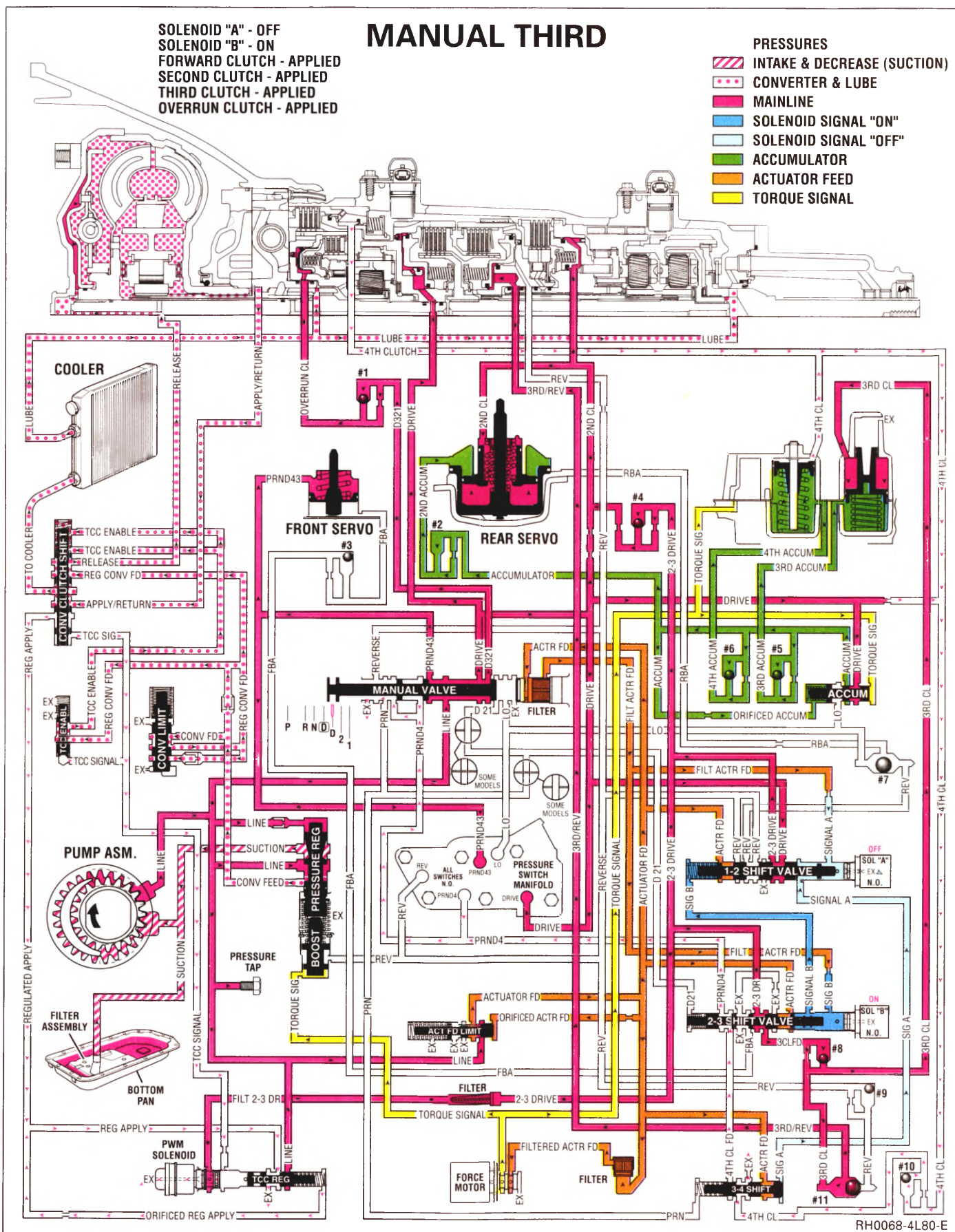


Figure 68 Manual Third

MANUAL THIRD (Torque Converter Clutch Applied)

Manual Third can be used to increase the performance of the vehicle by allowing higher engine RPM's for more torque. Manual Third will also provide vehicle engine compression braking when descending slight grades. Manual Third can be selected at any vehicle speed. The transmission will downshift into third gear at any vehicle speed.

- **Manual Valve:** In Manual Third range, line pressure from the pressure regulator valve is converted into PRND43, Drive and D321 pressures. The PRND43 pressure is directed to the pressure switch manifold and front servo, the Drive fluid pressure is directed to the forward clutch, and the D321 fluid pressure is directed to the #1 checkball and overrun clutch.
- **Transmission Fluid Pressure Switch ASM:** PRND43 and Drive fluid pressure from the manual valve is directed to the PRND43 switch and DR switch on the Transmission Fluid Pressure Switch ASM this sends a signal to the Powertrain Control Module (PCM) that the transmission is in manual third.
- **1-2 Solenoid:** De-energized, exhausting signal "A" pressure through the solenoid allowing spring pressure to move the 3-4 shift valve to the extreme right.
- **2-3 Solenoid:** Energized, the signal "B" fluid pressure moves the 2-3 shift valve against the spring force to the extreme left.
- **1-2 Shift Valve:** Held to the extreme right by signal "B" fluid and spring pressure. Drive fluid pressure from the manual valve is changed into 2-3 drive fluid pressure at the 1-2 shift valve, this pressure is directed to the 2-3 shift valve, Pulse Width Modulated (PWM) solenoid and the intermediate (second) clutch.
- **2-3 Shift Valve:** 2-3 fluid pressure from the 1-2 shift valve is changed into 3RD CL FD fluid pressure at the 2-3 shift valve, this fluid is directed to the #8 checkball which seats and forces the fluid through an orifice (where it becomes 3RD CL fluid pressure) and is directed to the third accumulator. 3RD CL FD fluid pressure is also directed to the #11 checkball which seats and forces the fluid through an orifice (which changes into 3RD/REV fluid pressure) and to the third clutch.
- **Rear Servo:** 2ND fluid pressure is supplied to the rear servo in the same manner as it is to the 2nd clutch. This fluid pressure is directed to the inner piston of the rear servo, thus applying the inner piston.
- **Front Servo:** PRND43 fluid pressure from the manual valve is directed to the front servo which assists the spring with holding the front servo off.
- **Overrun Clutch:** D321 fluid pressure from the manual valve seats the #1 checkball in the case and causes the fluid to flow through an orifice (which becomes overrun fluid pressure) through the case, pump housing and into the overrun clutch housing which applies the overrun clutch. Thus the overdrive roller clutch becomes ineffective and provides vehicle engine compression braking.
- **Forward Clutch:** Is applied by Drive fluid pressure from the manual valve.
- **Direct Clutch:** Third/reverse pressure from the #11 checkball flows through the case and into the center support to apply the inner piston area of the direct clutch.
- **Intermediate (Second) Clutch:** Is applied by 2ND fluid pressure from the 1-2 shift valve. 2-3 drive fluid pressure from the 1-2 shift valve seats the #4 checkball in the case and causes the fluid to flow through two orifices (which then becomes 2ND apply fluid pressure) into the center support which applies the intermediate (second) clutch.
- **Third Clutch Accumulator:** Third clutch pressure is also applied to the third clutch accumulator which is encased in the accumulator housing. This moves the third accumulator piston against the spring force and accumulator pressure which smooths the 2-3 shift.
- **Pulse Width Modulated (PWM) Solenoid:** When energized by the PCM signal pressure shifts the converter clutch shift valve, thus the Torque Converter Clutch (TCC) is applied. The signal pressure also acts on the torque converter clutch regulator valve which regulates output pressure to control the apply and release of the TCC.

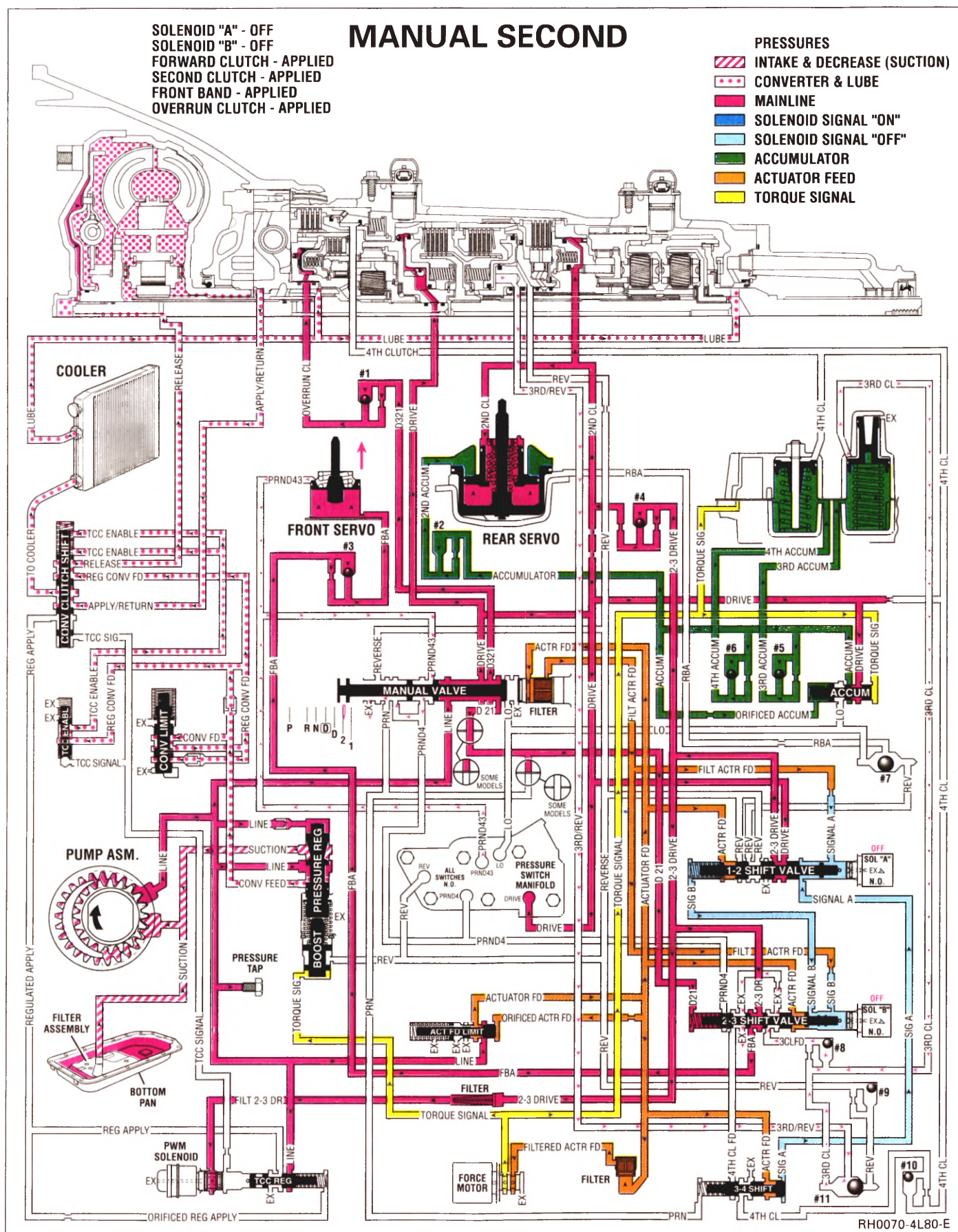


Figure 70 Manual Second

MANUAL SECOND

A Manual 3-2 downshift can be used to provide increased engine braking over Manual Third. This is done by moving the shift selector from the Manual Third position to the Manual Second position. Manual Second can be selected at any vehicle speed or from any gear range and the transmission will downshift into second gear.

- **Manual Valve:** In the Manual Second range, line pressure which turns into D 21 is directed to the 2-3 shift valve. The manual valve shuts off PRND4 fluid pressure to the Transmission Fluid Pressure Switch ASM and PRND43 fluid pressure to assist the front servo spring. This allows the front band to apply.
- **Transmission Fluid Pressure Switch ASM:** PRND43 pressure is shut off from the manual valve. This shuts off the electrical signal to the Powertrain Control Module (PCM).
- **1-2 Solenoid:** De-energized, exhausting signal "A" pressure through the solenoid allowing spring force to move the 1-2 shift valve to the extreme right.
- **2-3 Solenoid:** De-energized, exhausting signal "B" pressure through the solenoid, thus the 2-3 shift valve is forced to the extreme right by spring force and D 21 fluid pressure from the manual valve.
- **1-2 Shift Valve:** Is held to the extreme right by spring force. Drive fluid pressure from the manual valve is changed into 2-3 drive fluid pressure at the 1-2 shift valve, this pressure is directed to the 2-3 shift valve, PWM solenoid and the intermediate (second) clutch.
- **2-3 Shift Valve:** Is held to the extreme right by spring pressure and D 21 fluid pressure from the manual valve. 2-3 drive pressure from the 1-2 shift valve is changed into Front Band Apply (FBA) and directed to the front servo.
- **3-4 Shift Valve:** Held to the extreme right by spring force.
- **Front Servo:** Front Band Apply (FBA) fluid pressure from the 2-3 shift valve seats the #3 checkball, this causes the fluid to flow through an orifice, into the front servo piston housing which applies the front servo and band.
- **Forward Clutch:** Is applied by Drive fluid pressure from the manual valve.
- **Intermediate (Second) Clutch:** Is applied by 2ND fluid pressure from the 1-2 shift valve. 2-3 drive fluid pressure from the 1-2 shift valve seats the #4 checkball in the case and causes the fluid to flow through two orifices (which then becomes 2ND apply fluid pressure) into the center support which applies the intermediate (second) clutch.
- **Overrun Clutch:** D321 fluid pressure from the manual valve seats the #1 checkball in the case and causes the fluid to flow through an orifice (which becomes overrun fluid pressure) through the case, pump housing and into the overrun clutch housing which applies the overrun clutch. Thus the overdrive roller clutch becomes ineffective and provides vehicle engine compression braking.

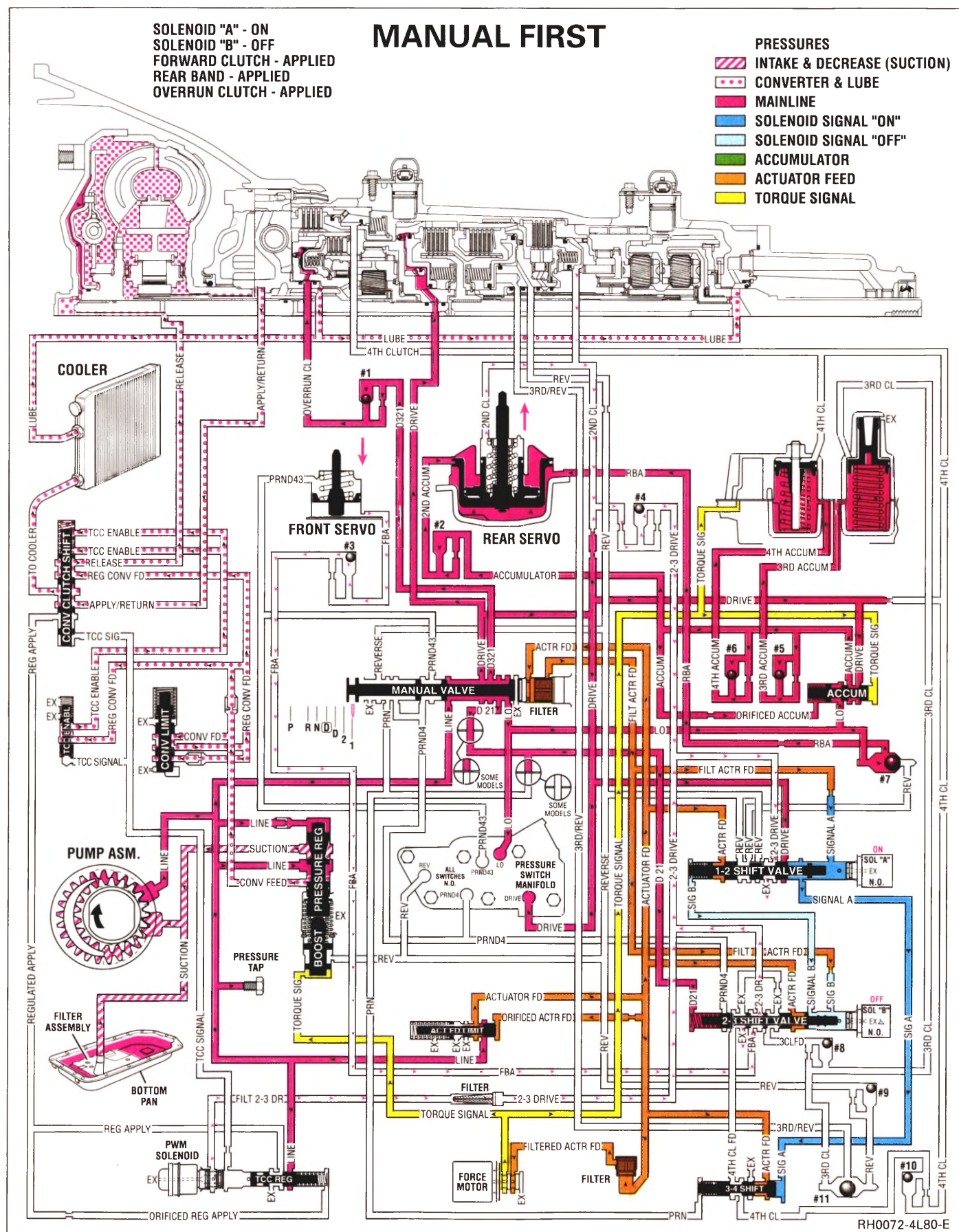


Figure 72 Manual First

MANUAL FIRST

Manual First can be used for maximum engine braking when descending steep grades. Manual First can be selected at any vehicle speed. However, the transmission will downshift into Manual Second and downshift to Manual First when vehicle is at a specified speed according to vehicle application.

- **Manual Valve:** In the Manual First range, line pressure from the pressure regulator valve is turned into Drive, D321, D 21, and LO fluid pressures. The Drive fluid pressure is directed to the forward clutch, the D321 fluid pressure is directed to the overrun clutch, D 21 fluid pressure is directed to the 2-3 shift valve, and the LO fluid pressure is directed to the Transmission Fluid Pressure Switch ASM and rear servo.
- **Transmission Fluid Pressure Switch ASM:** LO fluid pressure from the manual valve is directed to the LO pressure switch on the Transmission Fluid Pressure Switch ASM, this sends a signal to the Powertrain Control Module (PCM) that the transmission is in Manual First. Drive fluid pressure is also supplied to the Transmission Fluid Pressure Switch ASM as in all other gear ranges but Reverse, Neutral and Park.
- **1-2 Solenoid:** Energized, signal "A" fluid pressure forces the 1-2 and the 3-4 shift valves to the extreme left.
- **2-3 Solenoid:** De-energized, exhausting signal "B" fluid pressure through the solenoid.
- **1-2 Shift Valve:** Held to the extreme left by signal "A" fluid pressure. The actuator feed and drive pressures supplied to the 1-2 shift valve are blocked.
- **2-3 Shift Valve:** Is held to the extreme right by spring pressure and D 21 fluid pressure from the manual valve as in intermediate (second) gear.
- **3-4 Shift Valve:** Is forced to the extreme left by signal "A" pressure.
- **Rear Servo:** LO fluid pressure from the manual valve is directed to the #7 checkball, (which then becomes Rear Band Apply (RBA) fluid pressure) and into the rear servo which applies the rear band.
- **Forward Clutch:** Is applied by Drive fluid pressure from the manual valve.
- **Overrun Clutch:** D321 fluid pressure from the manual valve seats the #1 checkball in the case and causes the fluid to flow through an orifice (which becomes overrun fluid pressure) through the case, pump housing and into the overrun clutch housing which applies the overrun clutch. Thus the overdrive roller clutch becomes ineffective and provides vehicle engine compression braking.

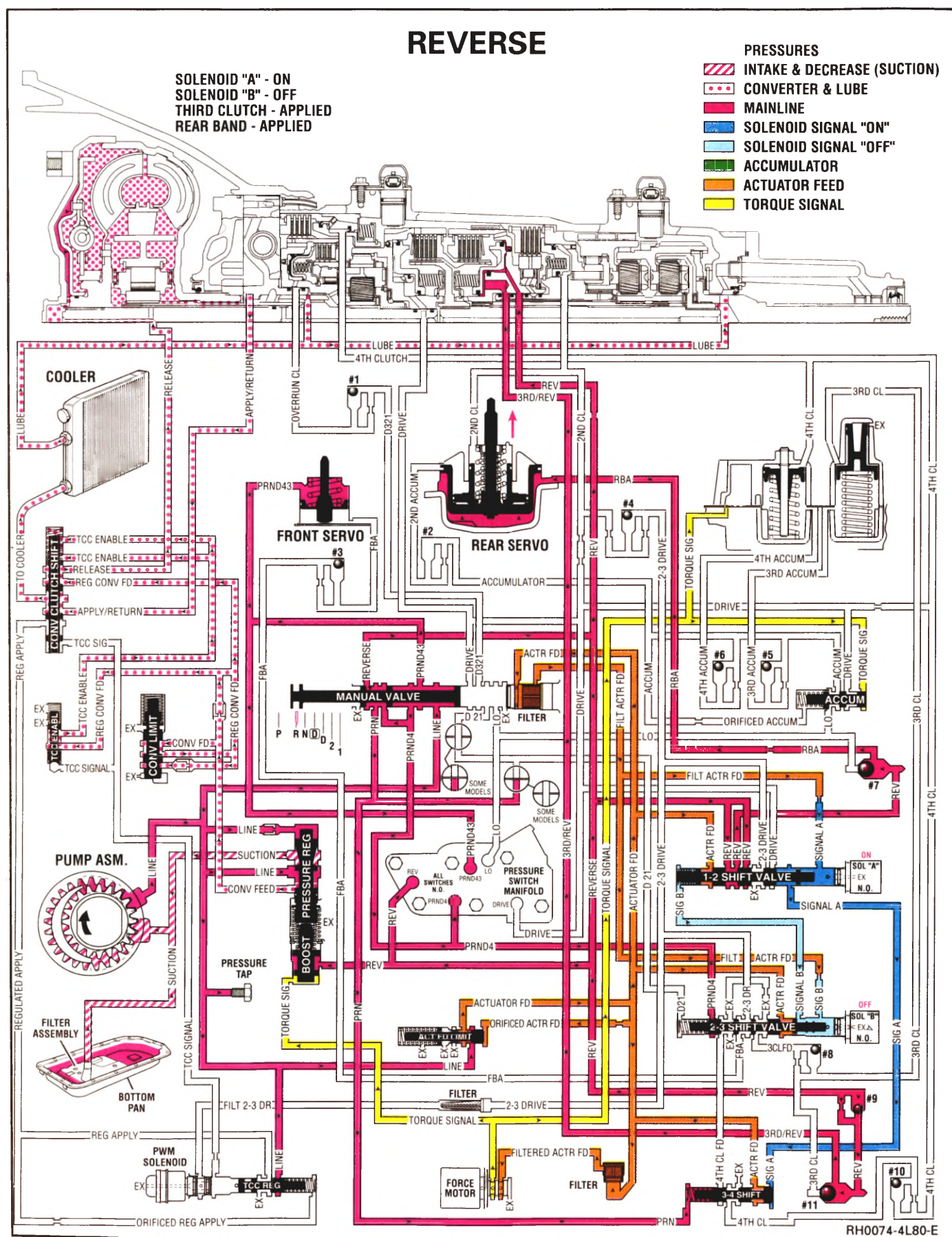


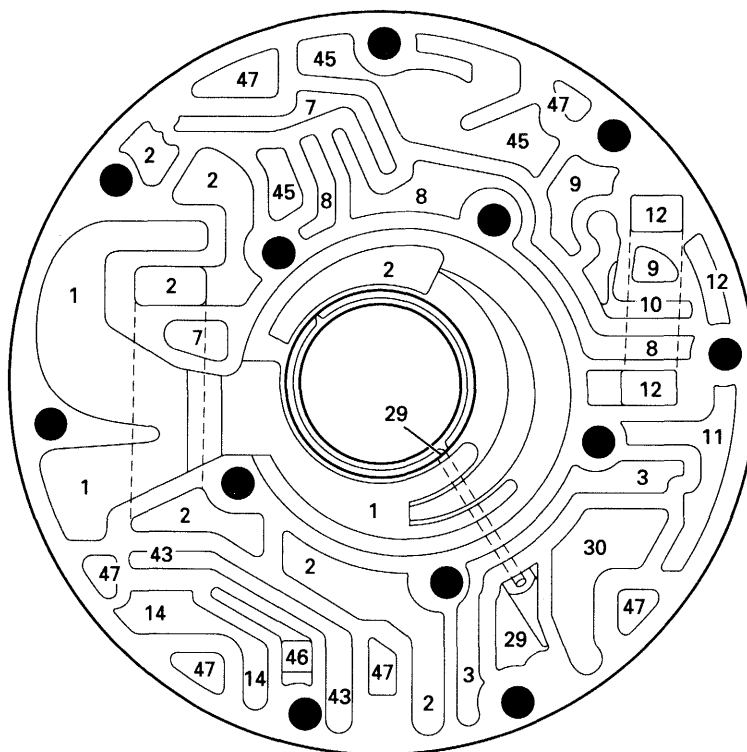
Figure 74 Reverse

REVERSE

When the gear selector lever is moved to the Reverse position, the manual valve blocks line fluid pressure from entering the Drive, D321, D 21, and LO fluid circuits. These fluids exhaust at the manual valve. The manual valve allows line fluid pressure to enter the REV, PRN, PRND43, and PRND4 hydraulic circuits.

- **Manual Valve:** In the Reverse range, line pressure from the pressure regulator valve is directed as REV, PRN, PRND4, and PRND43 fluid pressures at the manual valve. The REV fluid pressure is directed to the #9 checkball, direct clutch, 1-2 shift valve, and the pressure regulator boost valve. The PRN fluid is directed to the 3-4 shift valve, the PRND4 fluid is directed to the Transmission Fluid Pressure Switch ASM and 2-3 shift valve, and the PRND43 fluid is directed to the Transmission Fluid Pressure Switch ASM and the front servo.
- **Transmission Fluid Pressure Switch ASM:** REV, PRND4 and PRND43 fluid pressures from the manual valve are directed to the respective switches on the Transmission Fluid Pressure Switch ASM, this sends a signal to the Powertrain Control Module (PCM) that the transmission is in Reverse.
- **1-2 Solenoid:** Energized, signal "A" pressure forces the 1-2 shift valve to the extreme left.
- **2-3 Solenoid:** De-energized, exhausting signal "B" fluid through the solenoid.
- **1-2 Shift Valve:** Held to the extreme left by signal "A" fluid pressure. REV fluid pressure from the 1-2 shift valve is directed to and seats the #7 checkball, then to the rear servo which applies the rear band.
- **2-3 Shift Valve:** Is held to the extreme right by spring force. This blocks the PRND4 fluid pressure at the 2-3 shift valve which will be utilized in other gear ranges.
- **3-4 Shift Valve:** Is forced to the extreme right by PRN fluid pressure.
- **Rear Servo:** REV fluid pressure from the 1-2 shift valve is directed to and seats the #7 checkball, the fluid flows through an orifice, (which then becomes Rear Band Apply (RBA) fluid pressure) through the case into the rear servo which applies the rear band.
- **#9 and #11 Checkballs:** REV fluid pressure from the manual valve is directed to and seats the #9 checkball, this causes the fluid to flow through an orifice (which then becomes 3RD/REV fluid pressure) and seats the #11 checkball, and into the direct clutch.
- **Direct Clutch:** 3RD/REV fluid pressure is directed through the case, the center support and into the direct clutch inner piston area, REV fluid pressure is directed to the direct clutch outer piston. The combination of these two pressures apply the direct clutch. Using both fluid pressures on an increased area of the piston increases the holding capacity of the clutch.

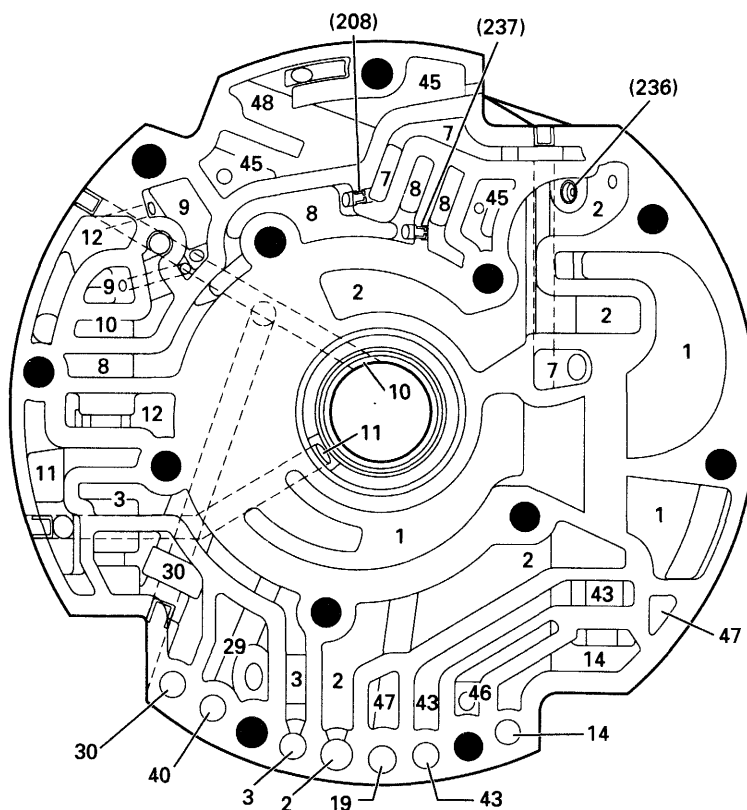
- 1 SUCTION
- 2 LINE
- 3 REGULATED APPLY
- 7 CONVERTER FEED
- 8 REGULATED CONVERTER FEED
- 9 TCC ENABLE
- 10 CONVERTER RELEASE
- 11 CONVERTER APPLY
- 12 COOLER
- 14 TORQUE SIGNAL
- 29 PUMP SEAL DRAINBACK
- 30 TCC SIGNAL
- 43 REVERSE
- 45 EXHAUST
- 47 VOID



RH0076-4L80-E

Figure 76 Pump Body Oil Passages

- 1 SUCTION
- 2 LINE
- 3 REGULATED APPLY
- 7 CONVERTER FEED
- 8 REGULATED CONVERTER FEED
- 9 TCC ENABLE
- 10 CONVERTER RELEASE
- 11 CONVERTER APPLY
- 12 COOLER
- 14 TORQUE SIGNAL
- 29 PUMP SEAL DRAINBACK
- 30 TCC SIGNAL
- 43 REVERSE
- 45 EXHAUST
- 47 VOID
- 48 VENT



RH0077-4L80-E

Figure 77 Pump Cover Oil Passages

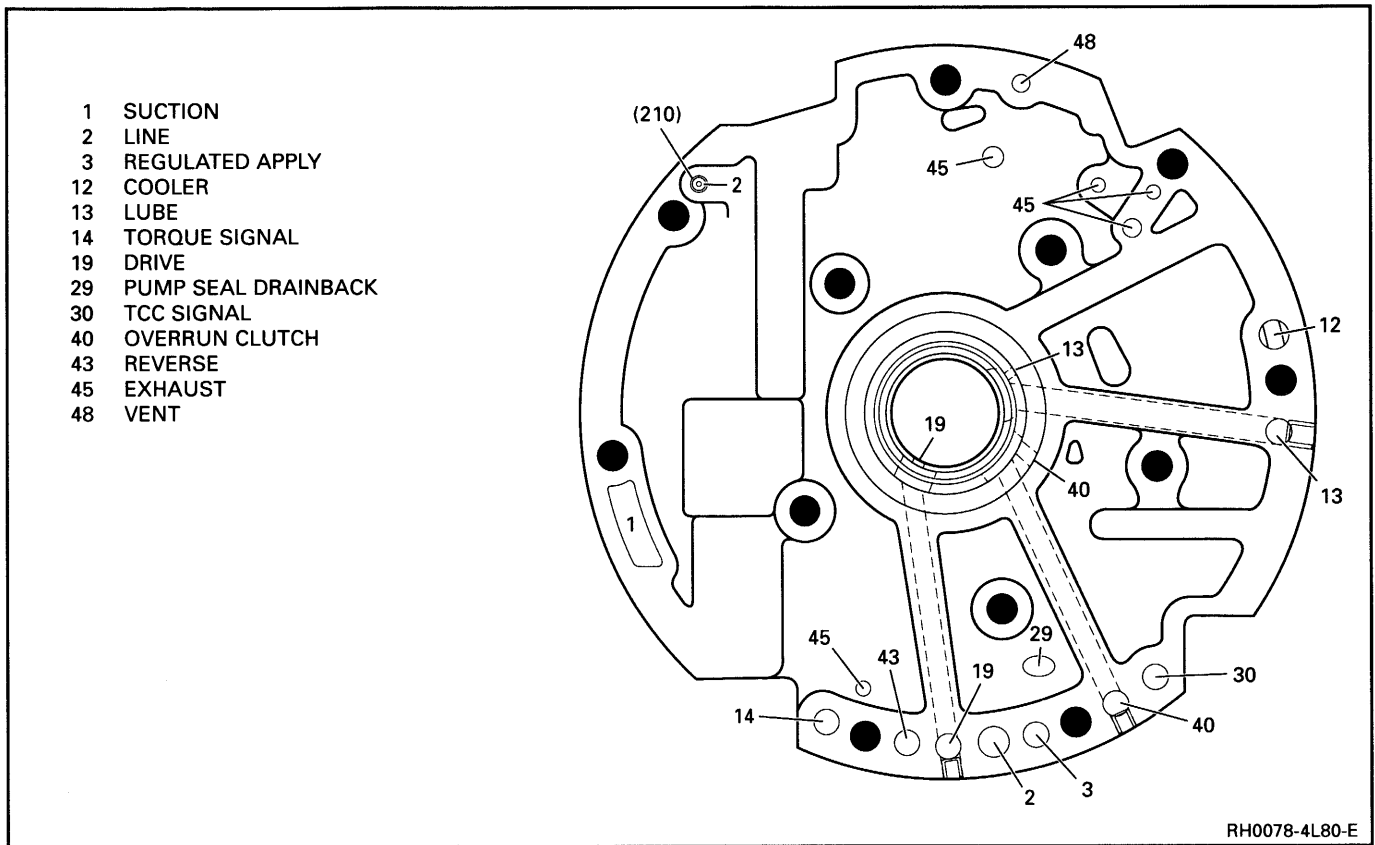


Figure 78 Pump Cover to Case Oil Passages

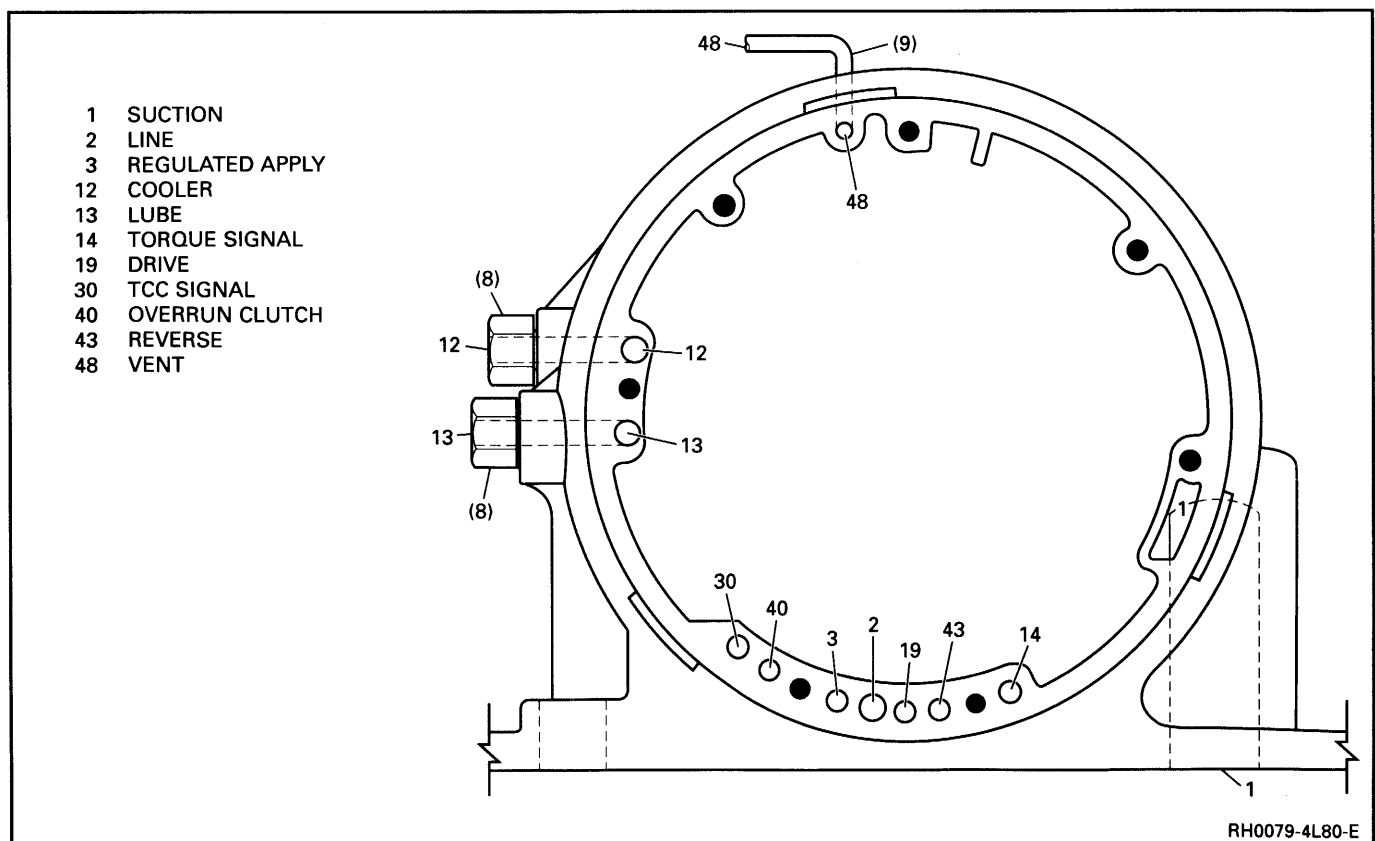


Figure 79 Case Oil Passages – Pump Attaching Surface

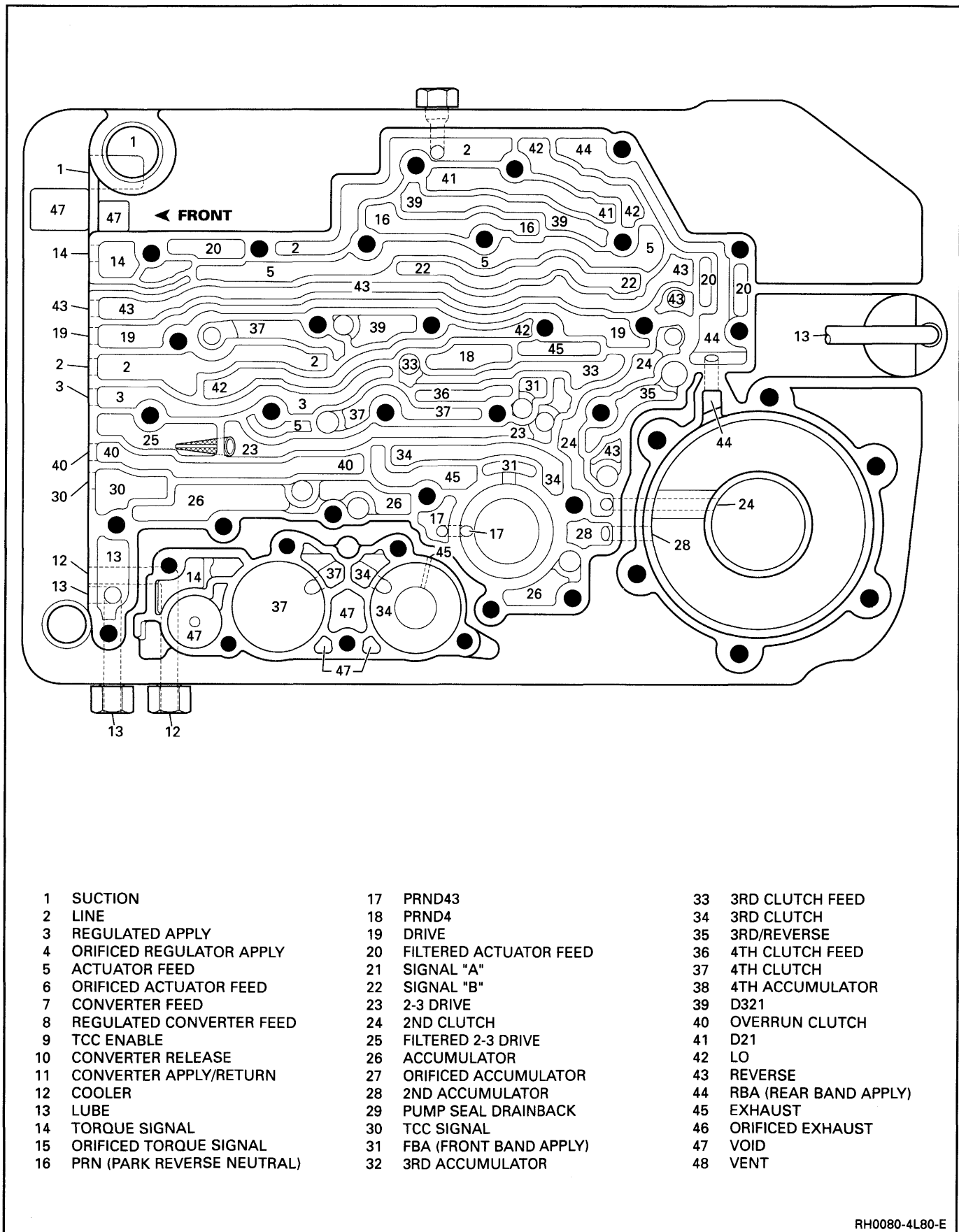


Figure 80 Case Oil Passages

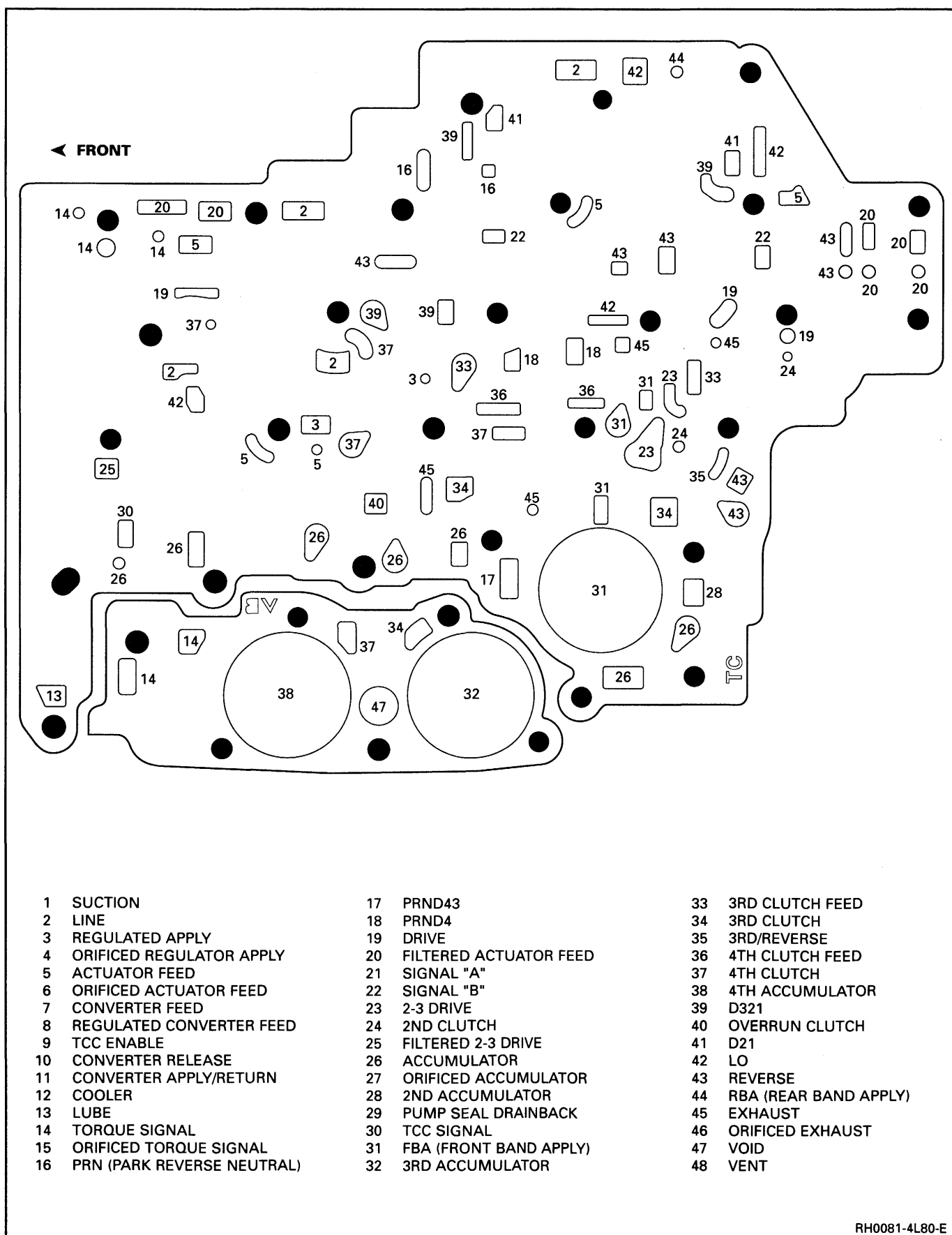
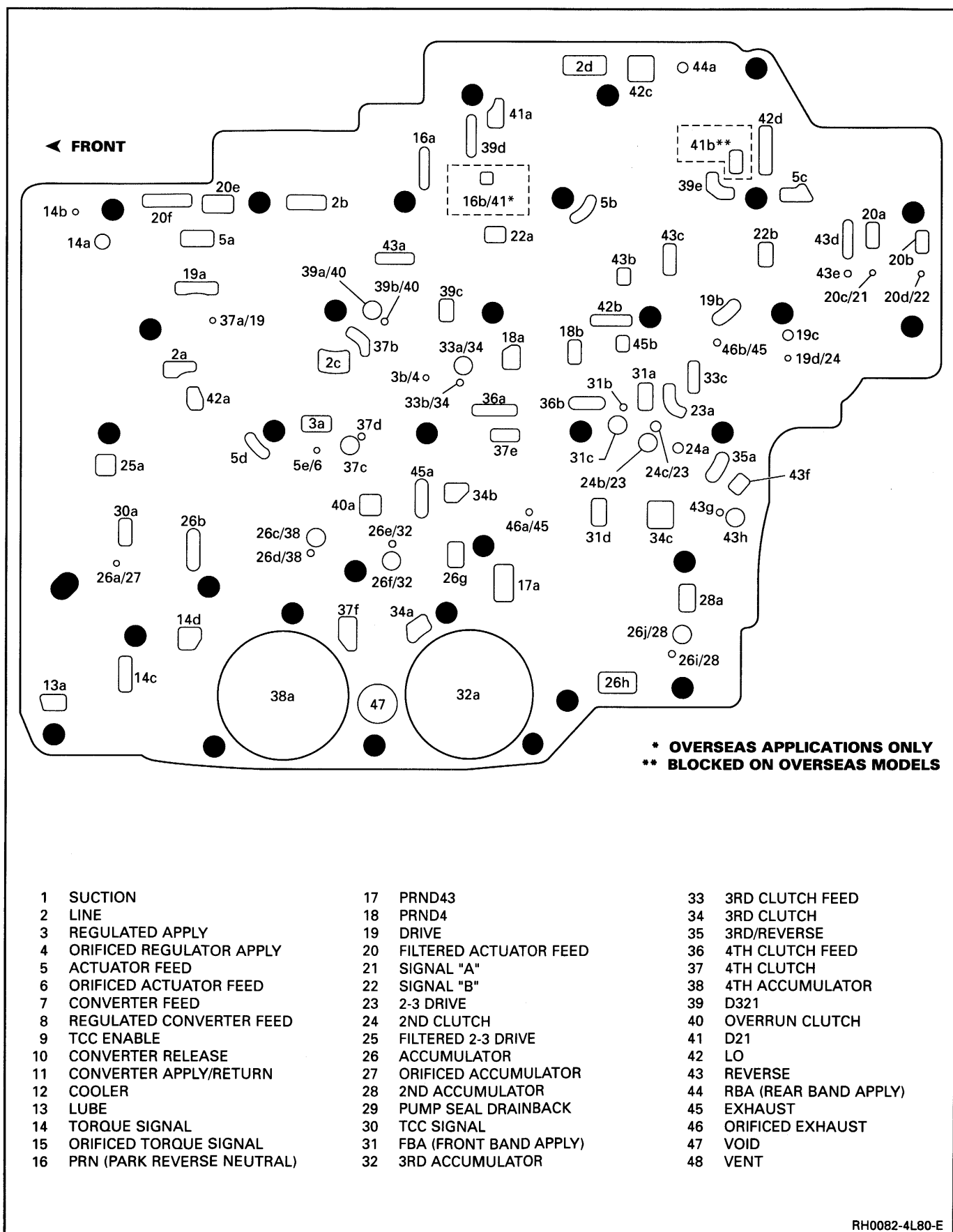
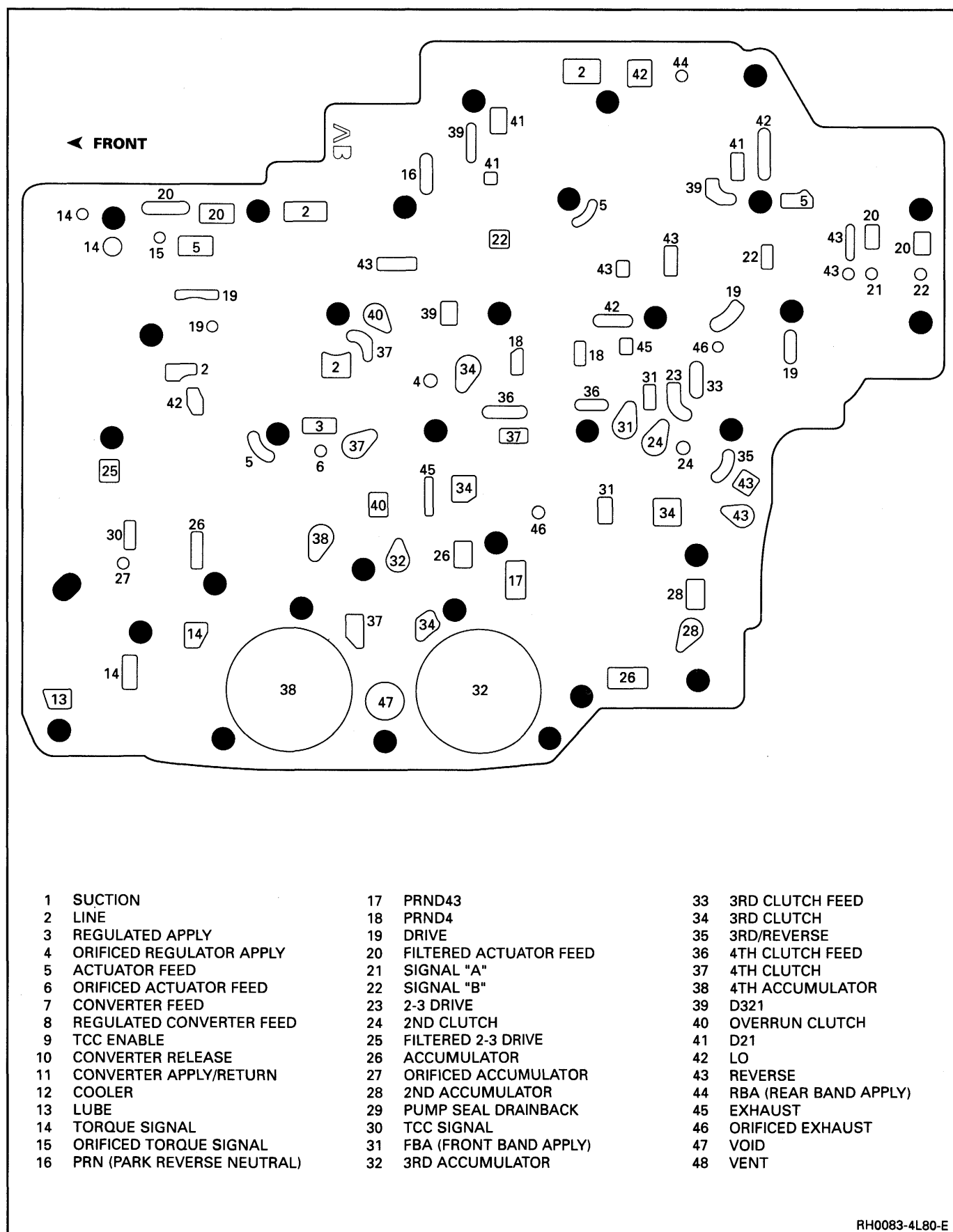


Figure 81 Spacer Plate to Case Gasket With Accumulator Housing Gasket



RH0082-4L80-E

Figure 82 Spacer Plate



RH0083-4L80-E

Figure 83 Spacer Plate to Valve Body Gasket

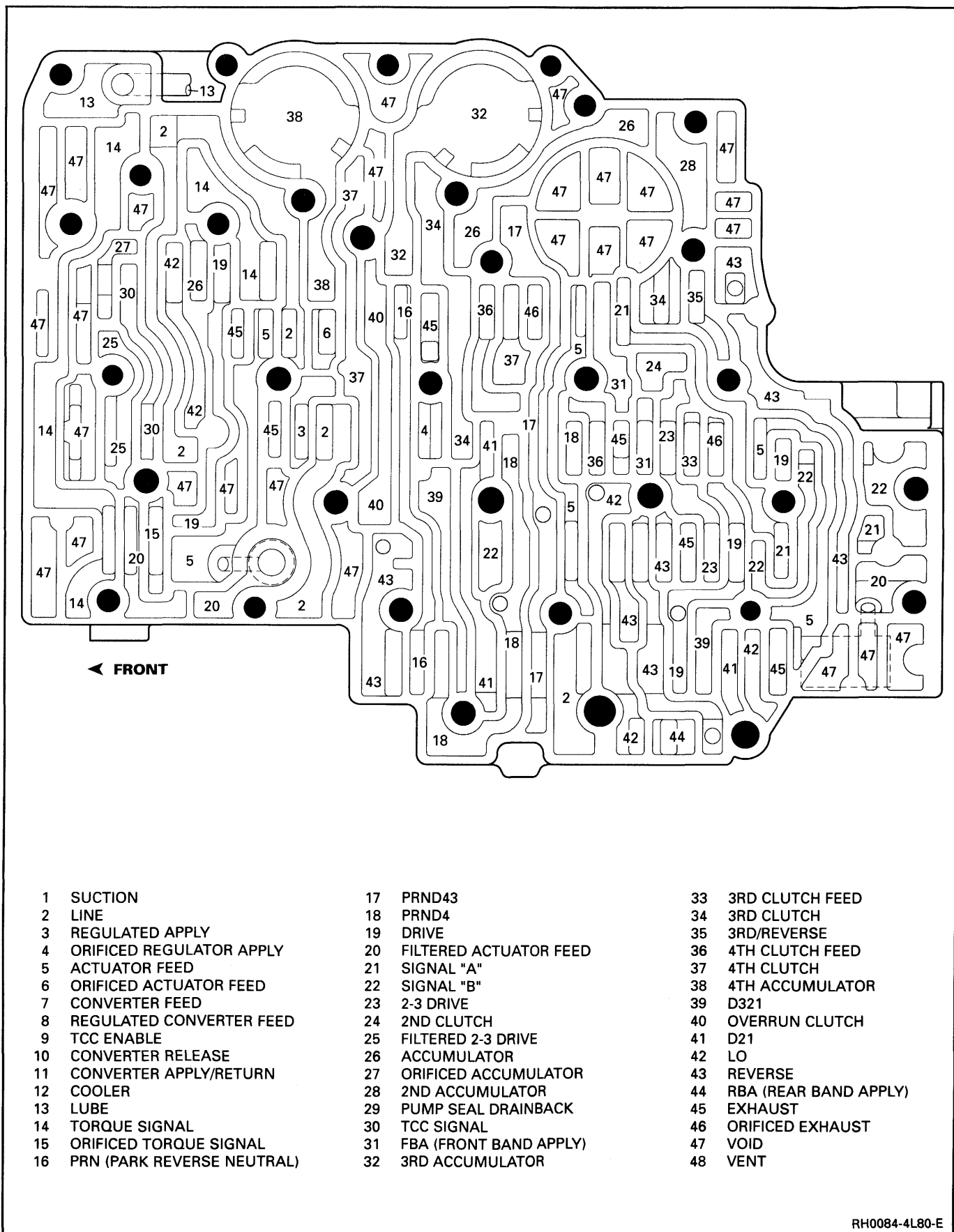
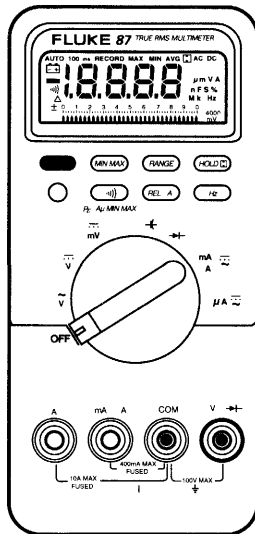


Figure 84 Valve Body Oil Passages



FLUKE 87 TRUE RMS
MULTIMETER
J 39200

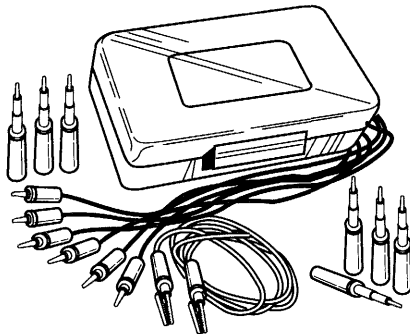
VOLTMETER – Voltage position measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 meg ohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings because they have a very high resistance.

AMMETER – When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information.

- Selector must be set properly for both function and range. DC is used for most automotive measurements.

OHMMETER – Measures resistance of circuit directly in ohms. Refer to meter instructions for more information.

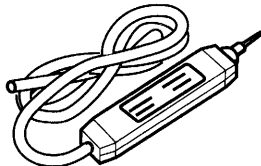
- OL display in all ranges indicates open circuit.
- Zero display in all ranges indicates a short circuit.
- An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit.
- Autoranges to the 400 Ω , 4 k Ω , 40 k Ω , 400 k Ω , 4 M Ω , or 40 M Ω resistance range.



J 35616-A

CONNECTOR TEST ADAPTER KIT

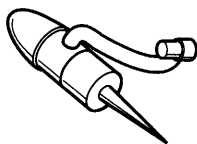
Assortment of flexible connectors to adapt a multimeter or jumper cords to connectors.



J 34636

CIRCUIT TESTER

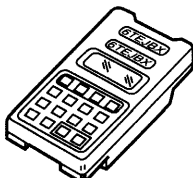
Used for checking all relays and solenoids before connecting them to a new ECM. Measures the circuit resistance and indicates pass or fail via green or red LED. Amber LED indicates current polarity. Can also be used as a non-powered continuity checker.



J 34142-A

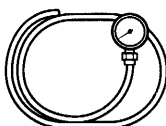
UNPOWERED TEST LIGHT

Used for checking wiring for complete circuit, short to ground, or voltage.



TECH 1 TESTER

Used to check solenoids and other electronic components. Can record vehicle data during dynamic testing, and turn some electronic components on and off.



J 21867

UNIVERSAL PRESSURE GAUGE SET

(9 Ft. Hose; 0-300 PSI)

Used for checking line pressure, pump output (min., max.) in all gear ranges.

RH0085-4L80-E

Figure 85 Electrical Diagnosis Tools

SECTION 7A17B

4L80-E AUTOMATIC TRANSMISSION ON-VEHICLE SERVICE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number for the application. If the correct part number is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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ON-VEHICLE SERVICE

PARTS CLEANING, INSPECTION, AND REPLACEMENT

- Use appropriate safety equipment such as:
 - Safety glasses.
 - Safety shoes.
 - Gloves.
- Keep the work area and tools clean.
- Clean the exterior of the transmission before removing any parts.
- Do not use wipe cloths or rags.
- Do not use solvents on rubber seals or plastic/Teflon® thrust washers.
- Blow out all passages with compressed air.
- Clean small passages with fine wire.
- Handle parts carefully to prevent damage.
- Lubricate all internal parts with transmission fluid during assembly.
- When installing screws, bolts, or studs into aluminum, always dip the threads in transmission fluid.
- Always use a torque wrench for the proper torque.
- Recondition damaged or stripped aluminum threads with thread inserts.
- Replace all gaskets and O-ring seals.
 - Do not use gasket cement or sealers.
- Replace plastic/Teflon® thrust washers and install using the proper seal protector.



Inspect

- Manual linkage for wear at the pivoting points, bent or broken links and rods.
- All seals, gaskets, O-rings, and mating surfaces for nicks, cuts, or other damage.
- Snap rings for expansion or compression, distortion, nicks, and proper ring to groove fit.
- Bearings and thrust surfaces for wear, scoring, and pitting.

FLYWHEEL AND TORQUE CONVERTER VIBRATION TEST

1. Start the engine.
2. With the engine at idle speed and the transmission in Park or Neutral, observe vibration.
3. Shut the engine off.

NOTICE: *Some engine/transmission combinations cannot be balanced in this manner due to limited clearances between the torque converter bolts and engine. Be sure bolts do not bottom out in lug nuts or the torque converter cover could be dented and cause internal damage.*



Remove or Disconnect

1. Converter cover attaching bolts.
2. Flywheel to torque converter attaching bolts.
3. Rotate the torque converter 1/3 turn.



Install or Connect

NOTICE: *For steps 1 and 2, refer to "Notice" on page 7A17B-1.*

1. Flywheel to torque converter attaching bolts.



Tighten

- Bolts to 44 N.m (33 lbs. ft.).

2. Converter cover bolts.



Tighten

- Bolts to 7 N.m (60 lbs. in.).

3. Start the engine and check for vibration. Repeat the procedure until the best possible balance is obtained.

FLUID LEAK DIAGNOSIS AND REPAIR

The cause of most external leaks can generally be located and repaired with the transmission in the vehicle.

METHODS FOR LOCATING LEAKS

General Method.

1. Verify the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut the engine off and look for fluid spots on the paper.
6. Make the necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder (foot powder) to the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Shut the engine off.
5. Inspect the suspected leak area and trace the leak path through the powder to find the source.
6. Make the necessary repairs.

Dye and Black Light Method

1. Follow the manufacture's recommendation for the amount of dye to be used.
2. Add dye to transmission oil and operate at normal operating temperature.
3. Find the leak with a black light.
4. Make the necessary repairs.

REPAIRING THE LEAK

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined

for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must also be repaired. Before attempting to repair a leak, check for the following conditions or causes:

Gaskets

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Improperly torqued fasteners or dirty/damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs, or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant used (where applicable).
- Porosity.

Seals

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Damaged seal bore (scratched, burred, or nicked).
- Damaged or worn seal.
- Improper installation.
- Cracks in component.
- Manual or output shaft surface scratched, nicked, or missing.
- Loose or worn bearing causing excess seal wear.
- Porosity.

POSSIBLE POINTS OF OIL LEAKS

1. Transmission and Transmission Oil Pan:
 - Attaching bolts not torqued correctly.
 - Improperly installed or damaged gasket.
 - Oil pan or mounting face not flat.
2. Case Leak:
 - Filler tube multilip seal damaged or missing.
 - Filler tube bracket misaligned.
 - Speedometer driven gear/speed sensor seal damaged.
 - Manual shaft seal damaged.
 - Oil cooler connector fittings loose or damaged.
 - Propeller shaft oil seal worn or damaged.
 - Governor cover.
 - Line pressure pipe plug loose.
 - Porous casting.
3. Leak at Converter End:
 - Converter seal damaged.
 - Seal lip cut (check converter hub for damage).
 - Bushing moved forward and damaged.
 - Garter spring missing from seal.
 - Converter leak in weld area.
 - Porous casting (case or pump).
4. Fluid Comes Out vent Pipe or Fill Tube.
 - Overfilled.
 - Water or coolant in fluid (fluid will appear milky).
 - Case porous.
 - Incorrect fluid level indicator.
 - Plugged vent.
 - Drain back holes plugged.
 - Misalignment of the oil pump to case gasket (if equipped).

CASE POROSITY REPAIR

1. Clean the leak area with solvent and air dry.

CAUTION: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Mix a sufficient amount of epoxy adhesive (GM P/N 1052533 or equivalent) following the manufacturer's recommendations.
3. While the transmission case is hot, apply epoxy adhesive with a clean, dry, soldering acid brush.
4. Allow the epoxy adhesive to cure for 3 hours before starting the engine.
5. Repeat fluid leak diagnosis procedures.

TORQUE CONVERTER CLUTCH ELECTRICAL CONTROLS

The torque converter clutch (TCC) system uses controls that are internal as well as external to the transmission. For internal control components of the TCC system, refer to the SECTION 7A17A.

The external control components of the TCC system include:

- Brake Release Switch—To avoid stalling the engine when braking, the converter clutch is released any time the brakes are applied.
- Powertrain Control Module—Receives input signals and grounds TCC solenoid to apply clutch when the proper operating conditions are met.
- Throttle Position Sensor—Sends throttle position information to the powertrain control module.
- Vacuum Sensor—Sends engine vacuum (load) information to the powertrain control module.
- Vehicle Speed Sensor—Sends vehicle speed information to the powertrain control module.
- Coolant Temperature Sensor—Sends engine coolant temperature information to the powertrain control module.

TORQUE CONVERTER CLUTCH DIAGNOSIS

To properly diagnose the torque converter clutch system, perform all electrical testing before hydraulic testing. Refer to "Torque Converter Clutch Electrical Controls" for additional testing of the torque converter clutch system.

SHIFT LINKAGE



Remove or Disconnect (Figure 1)

- Note the position of any washers, spacers, and insulators removed.
 - Apply the parking brake.
1. Screw (126) and washer (143).
 2. Rod (140) and swivel (144) from the shift lever (A).
 3. Retaining pin (132).
 4. Rod (140) from the equalizer lever (138).
 - Bearing (141) and the insulator (142).
 5. Retaining pin (127).

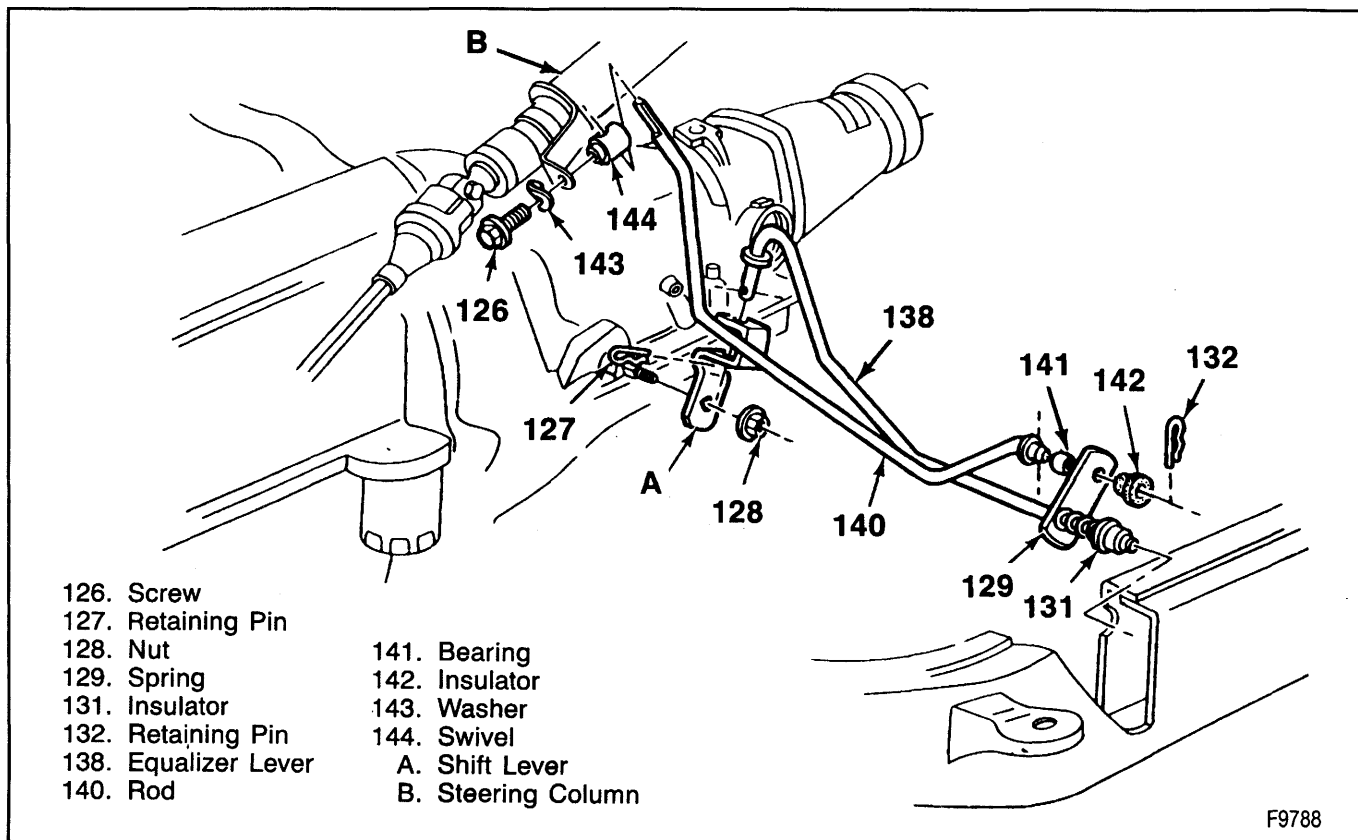


Figure 1—Shift Linkage

6. Equalizer lever (138).



Clean

- Metal parts using solvent. Wipe dry using a clean, dry rag.
- Rubber or nylon parts using soapy water. Wipe dry using a clean, dry rag.



Install or Connect (Figure 1)

NOTICE: Refer to "Notice" on page 7A17B-1.

1. Equalizer lever (138) and a new retaining pin (127).
2. Rod (140) to the equalizer lever (138).
 - Insulator (142) and bearing (141).
3. New retaining pin (132).
4. Swivel (144) and the rod (140) to the column lever.
 - Adjust the linkage. Refer to "Shift Linkage Adjustment."

SHIFT LINKAGE ADJUSTMENT



Remove or Disconnect (Figure 2)

- Apply the parking brake.
1. Loosen the screw (126).
 2. Put the column selector lever in the "N" (Neutral) position.
 - Put the lever in the neutral gate, do not use the indicator to find the neutral position.

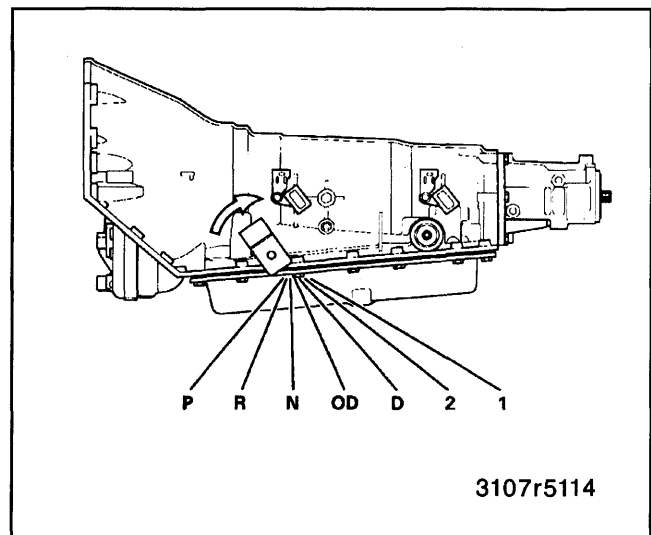


Figure 2—Shift Positions

3. Put the transmission in neutral.

- Move the shift lever (A) (figure 1) to the forward position, then back to the second detent (figure 2).

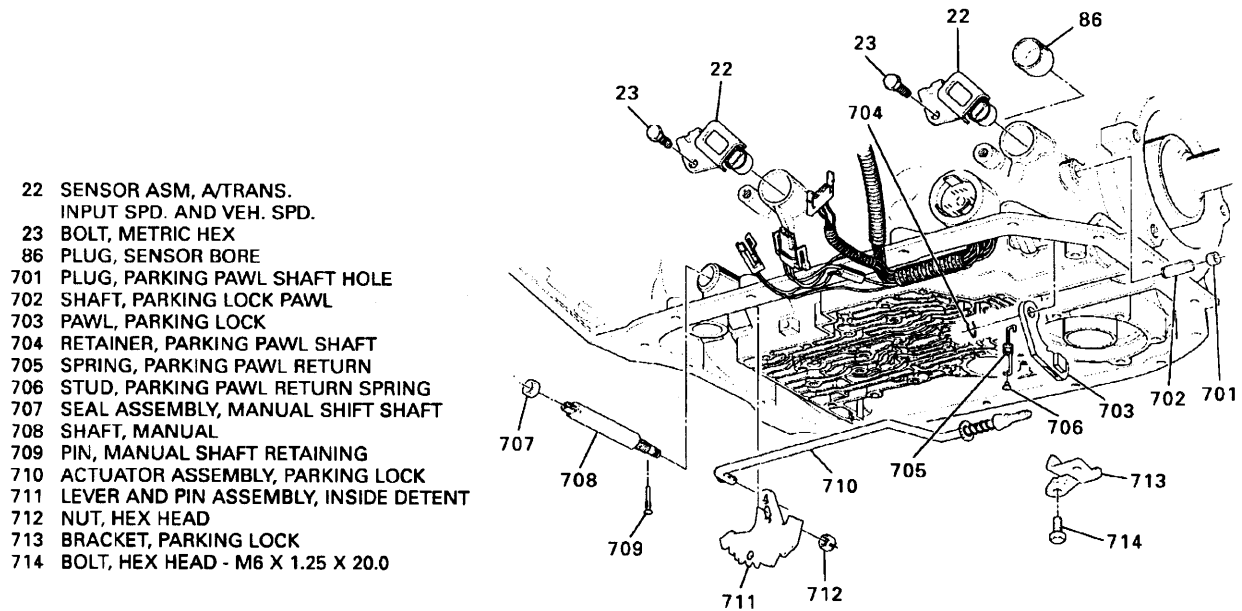
4. Hold the rod (140) tightly in the swivel (144).



Tighten

- Nut (126) to 30 N.m (20 lbs. ft.).

5. Put the column selector lever in the "P" (Park) position.



3107r5160

Figure 3—Park Lock Pawl and Actuator Assembly

6. Check the adjustment.
 - The column selector lever must go into all positions.
 - The engine must start in the "P" (Park) or "N" (Neutral) positions only.

CAUTION: With the selector lever in the "Park" position, the parking pawl should freely engage within the rear (reaction) internal gear lugs or output ring gear lugs and prevent the vehicle from rolling, which could cause personal injury.

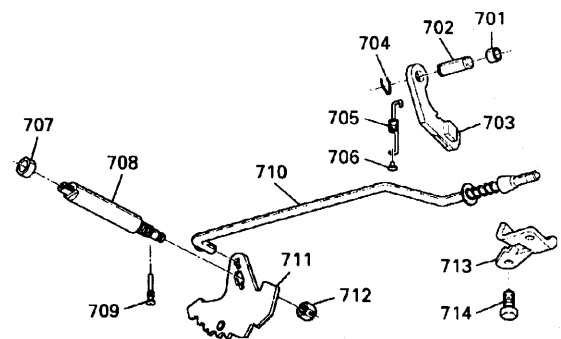
7. Align the indicator, if needed. Refer to SECTION 8C.
8. Release the parking brake.

PARK LOCK PAWL AND ACTUATOR ASSEMBLY



Remove or Disconnect (Figures 3 and 4)

1. Nut (712) and pin (709).
2. Detent lever (711) and actuator assembly (710).
3. Bolts (714) and parking pawl bracket (713).
4. Spring (705) and parking pawl return spring plug (706).
5. Plug (701) using modified screw extractor.
6. Parking pawl shaft retainer (704), shaft (702), and pawl (703).
7. Seal (707) and manual shaft (708).
8. Vehicle speed sensor and bracket assemblies (22).



3107r5161

Figure 4—Park Lock Pawl Assembly



Inspect (Figure 4)

1. Parking pawl (703) for:
 - Cracks.
 - Burrs.
 - Damage.
2. Parking pawl shaft (702) for:
 - Damage.
 - Freedom of fit.
3. Parking pawl return spring (705) for:
 - Distortion.
 - Damage.
4. Detent lever (711) and actuator (710) for:
 - Cracks.
 - Damage.
5. Manual shaft (708) for:
 - Damaged flats or threads.



Install or Connect (Figures 3 and 4)

1. Pawl shaft (702).
2. Parking pawl (703).
3. Plug (701) (using 5/16 rod) with Loctite® or equivalent.
4. Retainer (704).
5. Stud return spring (706).
6. Pawl return spring (705).
7. Detent lever (711) to the actuator assembly (710).
8. Actuator assembly (710) over the parking pawl (703).
9. Seal (707) and manual shaft (708).
10. Nut (712) using a 15-mm socket, on shaft (708).
11. Roll pin (709).

NOTICE: Refer to "Notice" on page 7A17B-1.

12. Parking lock bracket (713) with two bolts (714).



Tighten

- Bolts (714) to 24 N·m (18 lbs. ft.).

CHANGING THE FLUID AND FILTER



Remove or Disconnect (Figure 5)

- Raise the vehicle and support it with safety stands.
 - Place a drain pan under the transmission oil pan.
1. Seventeen oil pan bolts (27) from the front and sides only at first to drain the oil.
 - Use a 10-mm socket.
 - Loosen the rear oil pan bolts approximately 4 turns.



Important

- Use care, if prying down the oil pan, to prevent damaging the transmission case or the oil pan sealing surfaces.
2. Lightly tap the oil pan (28) with a rubber mallet or pry down to allow the fluid to drain.
 - Inspect the fluid color. Refer to SECTION 7A17A.

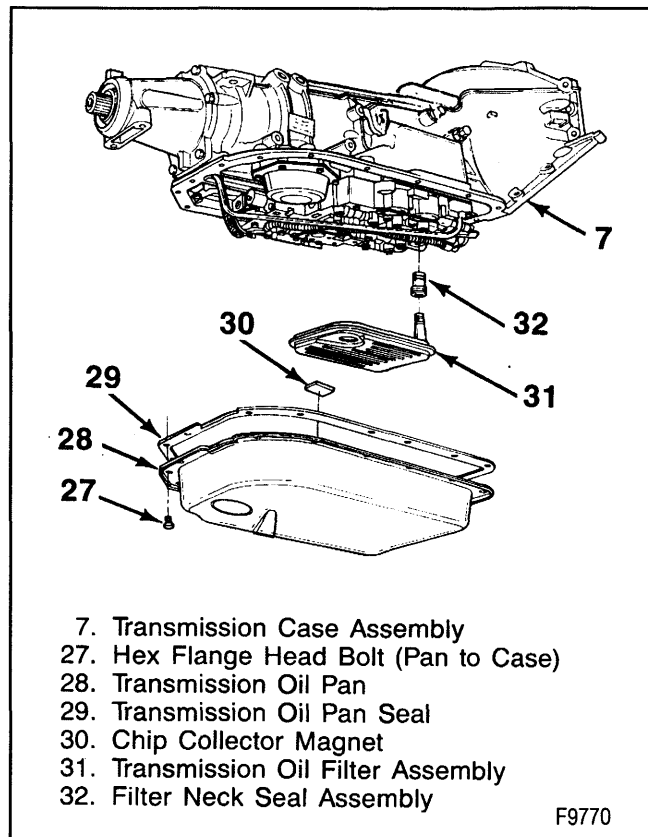


Figure 5—Transmission Pan and Filter Assembly

3. Remaining oil pan bolts (27), oil pan, gasket (29), which may be reused, and magnet (30).
4. Oil filter (31) and multilip seal (32).

- The seal may be stuck in the case.



Clean

- Transmission case and oil pan gasket surfaces with solvent and air dry.
 - All traces of old gasket material must be removed.



Install or Connect (Figure 5)

1. Inspect seal (32) inside of case (7).
2. Filter assembly (31).
3. Bottom pan gasket (29).
 - This gasket is reusable.
4. Magnet (30) into bottom pan.
5. Pan (28).

NOTICE: Refer to "Notice" on page 7A17B-1.

6. Seventeen oil pan bolts (27) using a 10-mm socket.



Tighten

- Bolts (27) to 24 N·m (18 lbs. ft.).
7. New transmission fluid.
 - Lower the vehicle.

- Fill the transmission to the proper level with DEXRON® 3 or DEXRON® IIE Transmission Fluid.

! Important

- Do not overfill.
8. Check the oil pan gasket for leaks.

PRESSURE REGULATOR REPLACEMENT

↔ Remove or Disconnect (Figures 6 and 7)

- Raise the vehicle.
1. The oil pan and filter. Refer to "Changing the Fluid and Filter."
 2. Retainer ring (226), reverse boost bushing (227), reverse boost valve (228), pressure regulator spring retainer (229), pressure regulator spring (230), and pressure regulator valve (231).

→ Install or Connect Figures (6 and 7)

1. Pressure regulator valve (231). Retain in position with TRANSJEL® J 36850.
 2. Pre-assemble reverse boost valve bushing (227), new reverse boost valve (228), new pressure regulator spring retainer (229), added isolator pressure regulator spring (238), and pressure regulator spring (230).
 3. Pre-assembled parts into the pump bore.
 4. Retainer ring (226), while holding reverse boost valve bushing in place.
 - Make sure the retainer ring (226) is in the groove.
 5. Oil pan and filter. Refer to "Changing the Fluid and Filter."
- Lower the vehicle.

TORQUE CONVERTER CLUTCH (TCC) VALVE AND SPRING REPLACEMENT

↔ Remove or Disconnect (Figures 6 and 7)

- Raise the vehicle.
1. Oil pan and filter. Refer to "Changing the Fluid and Filter."
 - Wiring harness (if needed).
 2. Snap ring (221), plug (232), valve (223), and spring (224).

→ Install or Connect Figures 78 and 79)

1. Spring (224) and valve (223), plug (232), install snap ring (221).
- Wiring harness if it was removed.
2. Filter and oil pan and fluid. Refer to "Changing the Fluid and Filter."
- Lower the vehicle.

CONTROL VALVE REMOVAL AND DISASSEMBLY

- Raise the vehicle.
 - Lower the transmission, if needed, for clearance. Refer to "Transmission Replacement."
1. Remove the oil pan and filter. Refer to "Changing the Fluid and Filter."

↔ Remove or Disconnect (Figure 8)

- Connector wire harness assembly (34) from six hookups.

! Important

- Use a cap to cover electrical pins at the case connection.

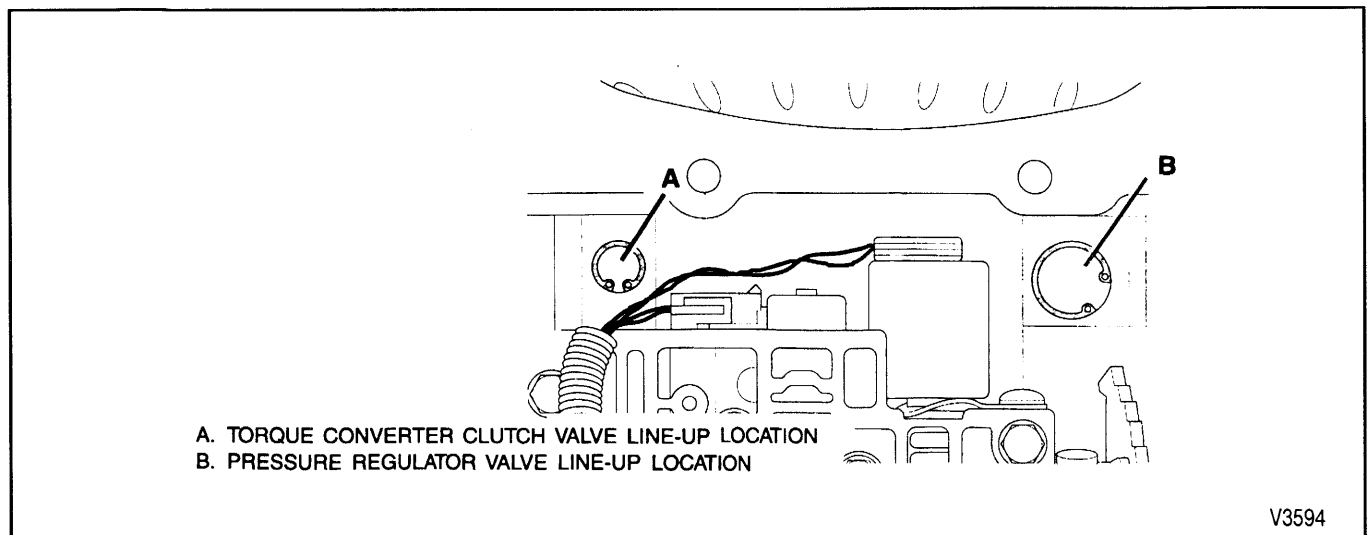
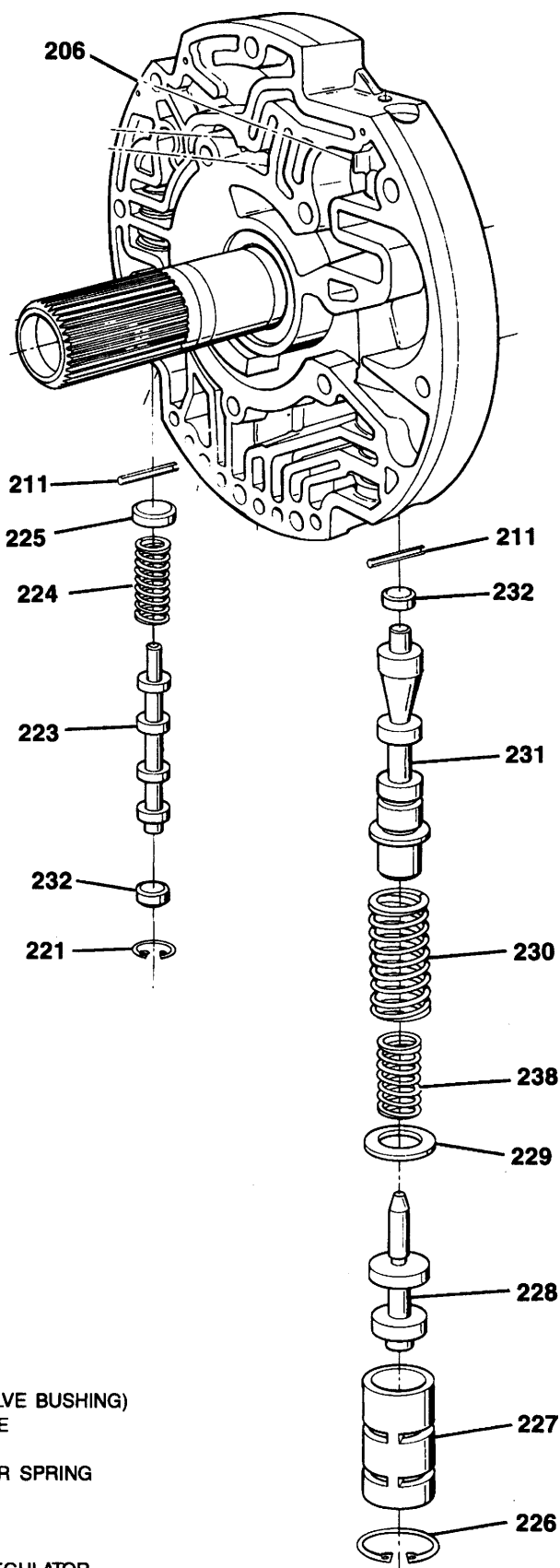


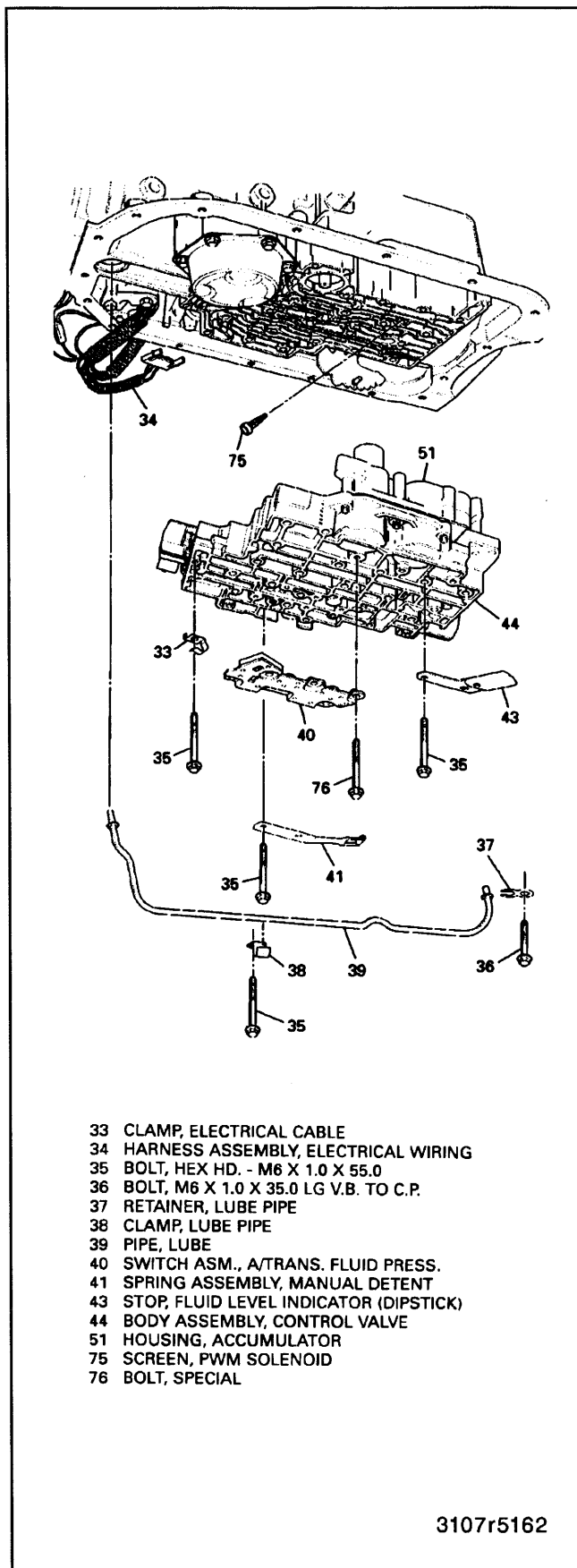
Figure 6—Pressure Regulator Valve and Torque Converter Clutch Valve Lineups



- 206. COVER, PUMP
- 211. PIN, COILED SPRING (3)
- 221. RING, SNAP
- 223. VALVE, TCC
- 224. SPRING, TCC VALVE
- 225. PLUG, TCC VALVE BORE
- 226. RING, RETAINER (REV. BOOST VALVE BUSHING)
- 227. BUSHING, REVERSE BOOST VALVE
- 228. VALVE, REVERSE BOOST
- 229. RETAINER, PRESSURE REGULATOR SPRING
- 230. SPRING, PRESSURE REGULATOR
- 231. VALVE, PRESSURE REGULATOR
- 232. PLUG, VALVE BORE
- 238. SPRING, ISOLATOR PRESSURE REGULATOR

V3360

Figure 7—Pressure Regulator Valve and Torque Converter Clutch Valve Lineups (Disassembled View)



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Figure 8—Control Valve Assembly

1. Twenty-one bolts (35) from the valve body assembly (401) and manual detent spring assembly (41).
2. Six bolts (76) using an 8-mm socket, from pressure manifold assembly (40).
 - Be sure the five O-rings are attached to the pressure manifold assembly.
3. Three wiring clips (33), fluid level indicator stop (43), one bolt (36) using a 10-mm socket, lube pipe (39), lube pipe retainer (37), and clamp (38).
4. Control valve assembly (44) including the accumulator housing assembly (51), valve body gaskets (45 and 48), spacer plate (46), and accumulator gasket (47).
 - Make sure there is no gasket material left on the case surface.

NOTICE: Do not use a magnet. It could magnetize the check balls causing metal particles to stick to them. This could cause damage to the transmission.

5. Eight check balls (54) from case passages.
6. PWM (Pulse Width Modulation) solenoid screen (75).

The use of a honing stone, fine sandpaper, or crocus cloth is not recommended for servicing stuck valves. All valve lands have sharply machined corners that are necessary to cleaning the bore. If these corners are rounded, foreign material could wedge between the valve and the bore causing the valve to stick. If it is found necessary to clean a valve, use micro fine lapping compound (900 grit or finer).

Too much lapping of the valve will cause excessive clearances and increase the chance of a valve not operating.



Clean (Figures 9 and 10)

- Control valve assembly and accumulator housing (51) thoroughly in clean solvent.
- Air dry.



Disassemble (Figure 9 and 10)

- Control valve assembly/accumulator housing assembly.
 - Position as shown on a clean surface.
 - Remove valve trains and accumulator pistons.

CAUTION: Some valves are under pressure. Cover the bores while removing the roll pins or personal injury could result.

- Remove blind hole roll pins with a modified drill bit.
- Valves, springs, bushings, and pistons must be laid out on a clean surface in the exact sequence they are removed.



Clean

- All valves, springs, bushings, pistons, control valve body, and accumulator housing in clean solvent.
- Dry using compressed air.

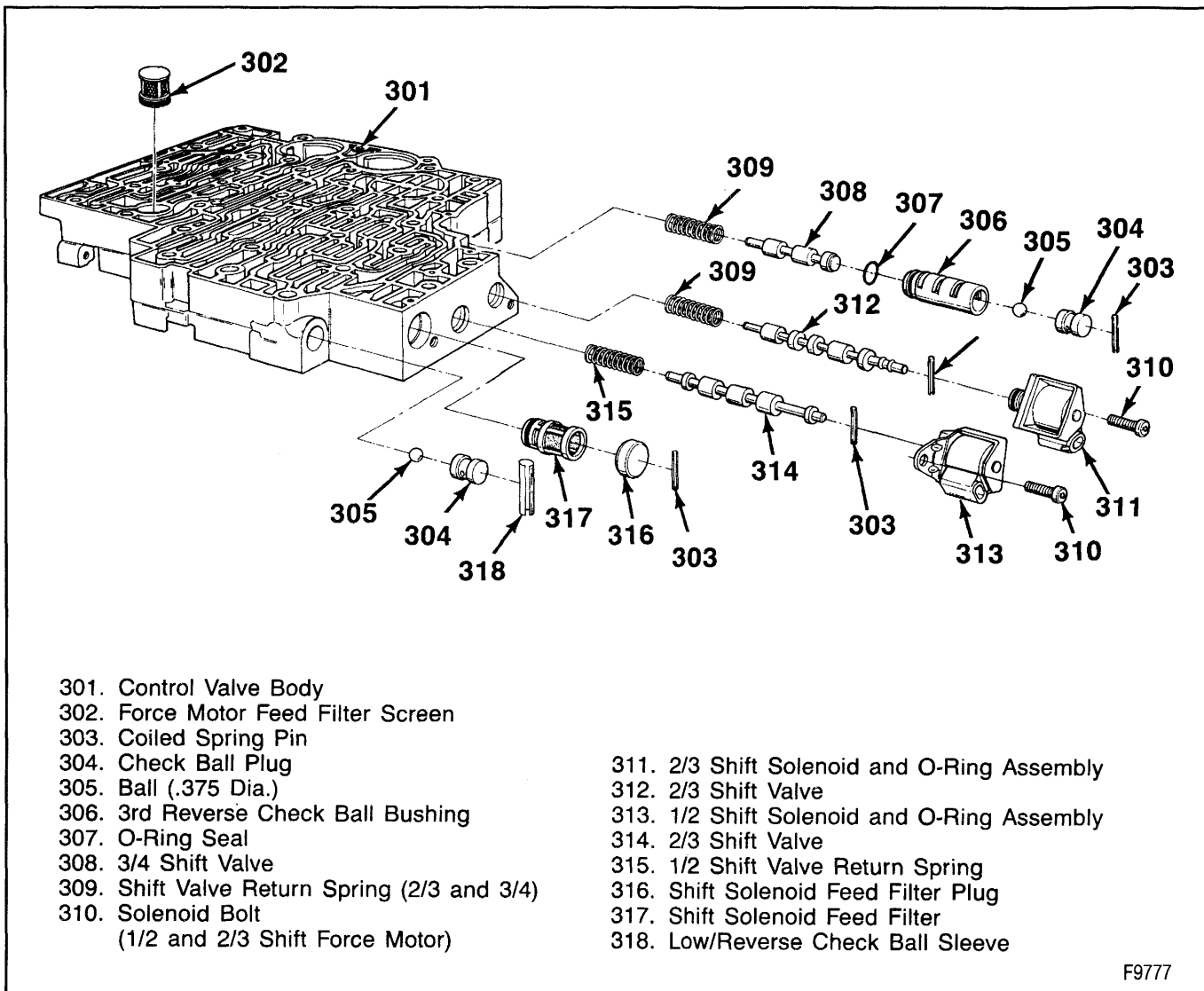


Figure 9—Valve Body Assembly Showing Shift Solenoids



Inspect

1. All valves, pistons, and bushings for:
 - Porosity.
 - Scoring.
 - Nicks.
 - Scratches.
2. Pistons for:
 - Seal damage.
3. Springs for:
 - Damaged or distorted coils.
4. Valve body casting and accumulator housing for:
 - Porosity.
 - Cracks.
 - Interconnected passages.
 - Damaged machined surfaces.
5. Solenoid, connectors, and switches.
6. PWM solenoid screen (75).
 - Inspect, clean, and replace if necessary.

ACCUMULATOR HOUSING ASSEMBLY REMOVAL



Remove or Disconnect (Figure 11)

1. Bolts (53) using an 8-mm socket.
2. Accumulator housing assembly.
3. Gasket accumulator housing (47).
4. Spacer plate (46).
5. Gasket (45) valve body spacer.
6. Gasket (48) accumulator housing to spacer plate.

ACCUMULATOR HOUSING ASSEMBLY



Disassemble (Figure 12)

1. Snap ring (402) from outside housing, pin (408), snap ring (402), piston (407), and spring (49).
2. Third clutch piston (405) and spring (50).
3. Seals (404 and 406).

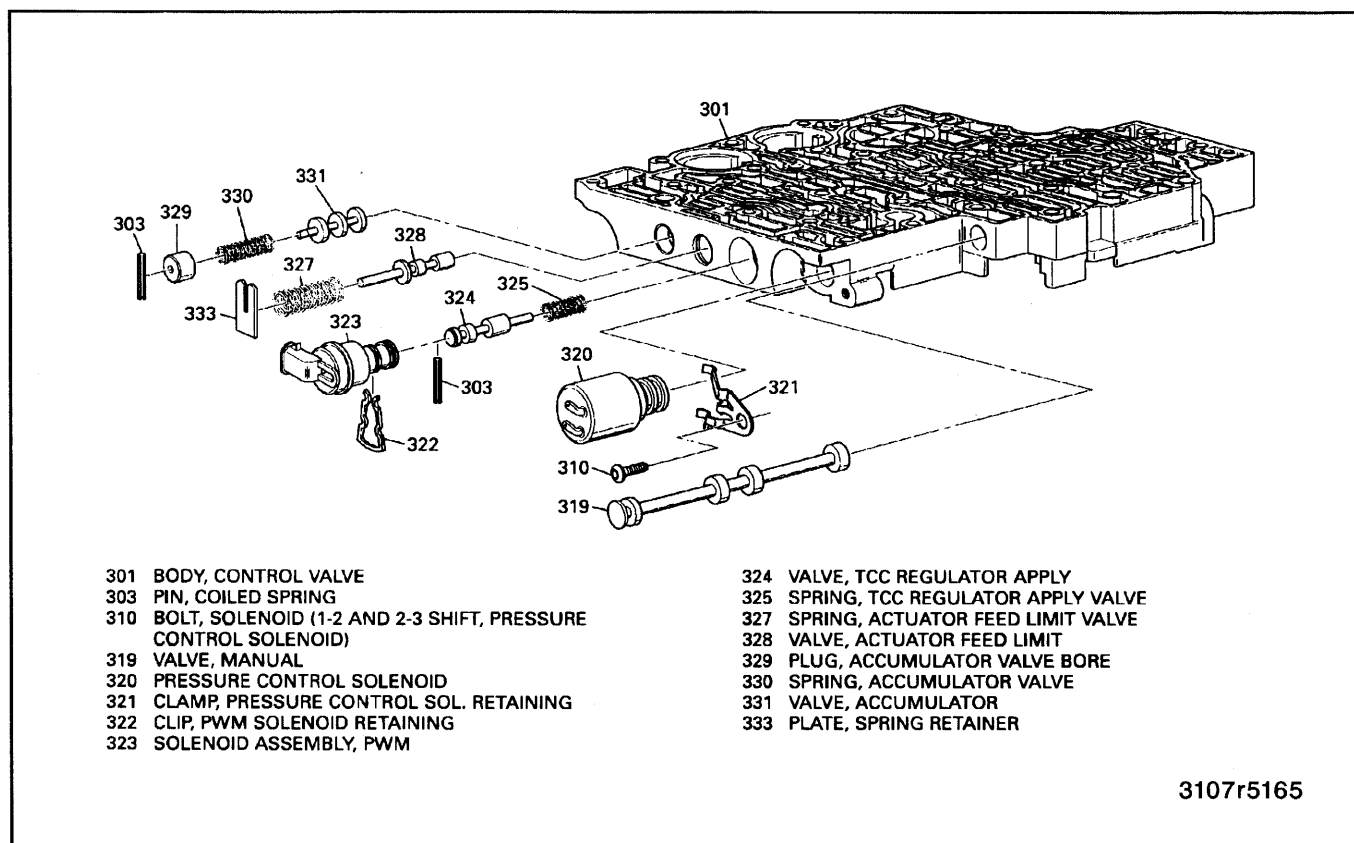


Figure 10—Valve Body Assembly Showing Force Motors



Assemble

- Accumulator housing assembly components exactly as shown. Notice the positions of the valve and pistons.

CONTROL VALVE ASSEMBLY



Assemble (Figures 9 and 10)

- Control valve assembly components exactly as shown. Notice the position of the valve lands and bushing passages.

INSTALLING CONTROL VALVE ASSEMBLY AND ACCUMULATOR HOUSING



Assemble (Figures 11 and 13)

1. Guide pins into valve body.
2. Gasket (45).
3. Spacer plate (46).
4. Gasket (47).
5. Accumulator housing assembly (51) onto valve body assembly (44).
6. Bolts (53) using an 8-mm socket, through accumulator housing into valve body assembly.
7. Guide pins.



Install or Connect (Figures 11 and 14)

NOTICE: For steps 8, 11, and 12, refer to "Notice" on page 7A17B-1.

1. Eight check balls (54) in proper location into case fluid passages.
2. Gasket (48).
3. Complete valve body assembly (44) onto the case (7). Make sure to attach the manual shaft (708) to the detent lever and pin assembly (711).
4. Pressure switch manifold (PSM) (40) onto the valve body assembly (44).
5. Spring and roller assembly (41) into place.
6. Three wiring clips (33) and fluid indicator stop (43).
7. Twenty-one bolts (35) using a 10-mm socket.
8. Six bolts (76) using an 8-mm socket into the PSM (Pressure Switch Manifold) (40).



Tighten

- Bolts (35 and 76) to 11 N·m (96 lbs. in.).
9. Attach wiring harness (34) to six connectors. Put large end into case first, pressure switch hook up, solenoid A (1/2) and B (2/3), temperature sensor, PWM solenoid, and force motor.
 10. Lube pipe (39) long end into case.
 11. Lube pipe clip (37) with short bolt (36).

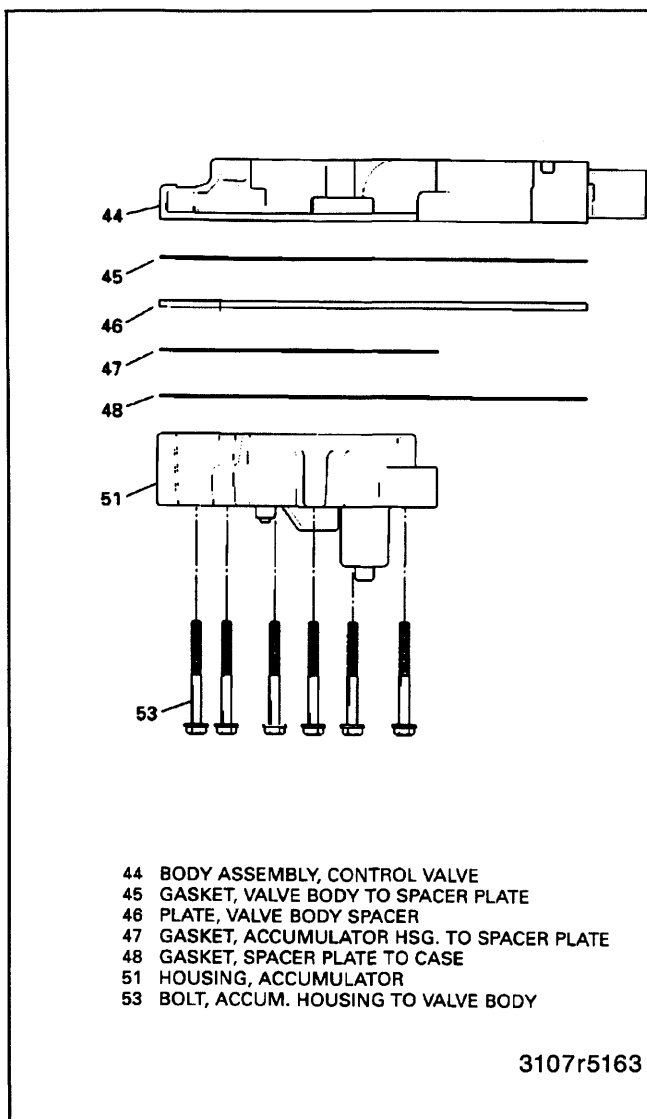


Figure 11—Accumulator Housing



Tighten

- Bolts (36) to 11 N.m (96 lbs. in.).

12. Twenty-one bolts (35) using a 10-mm socket, attach valve body to case (7).



Tighten

- Bolts (35) to 11 N.m (96 lbs. in.).



Install or Connect

1. The oil pan and filter. Refer to "Changing the Fluid and Filter."

- Raise the transmission if it was lowered for clearance. Refer to "Transmission Replacement."
- Lower the vehicle.

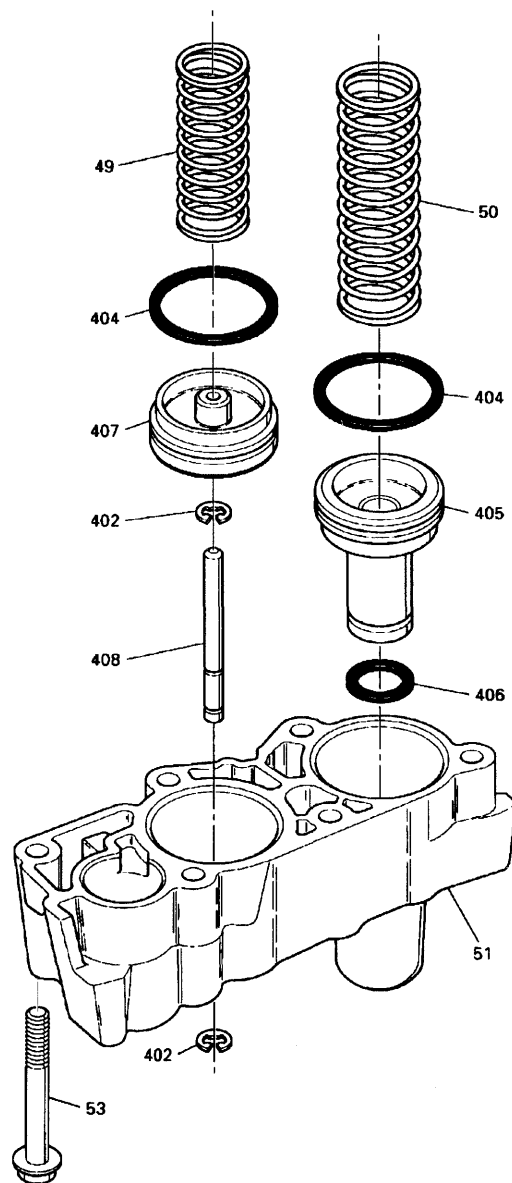


Figure 12—Accumulator Housing Assembly

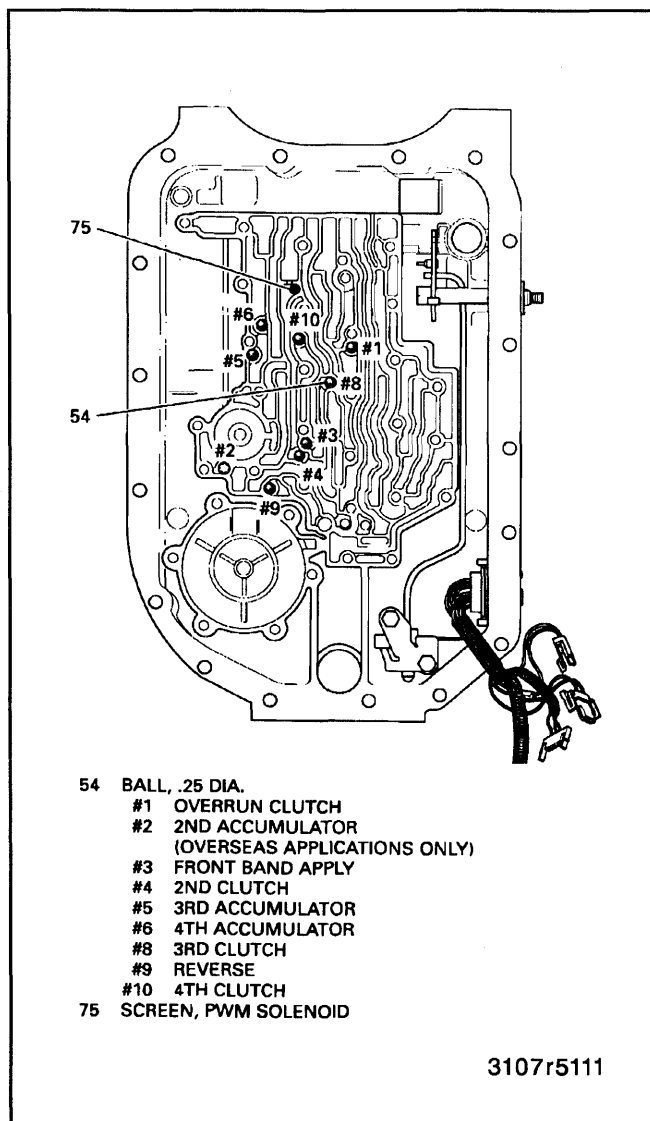


Figure 13—Check Ball Location

FRONT SERVO REPLACEMENT



Remove or Disconnect (Figure 15)

1. Front servo piston assembly (55 through 57), retainer (56), and spring (60).
2. Six rear servo bolts (61) using a 10-mm socket, cover (62), and gasket (63).



Inspect (Figure 15)

1. Front servo piston (58) for:
 - Porosity or damage.
 - Seal and seal ring groove for damage.
2. Piston pin (55) for:
 - Wear.
3. Spring (60) for:
 - Distortion.
4. Servo bore for:
 - Wear or scoring.



Clean

- All components.

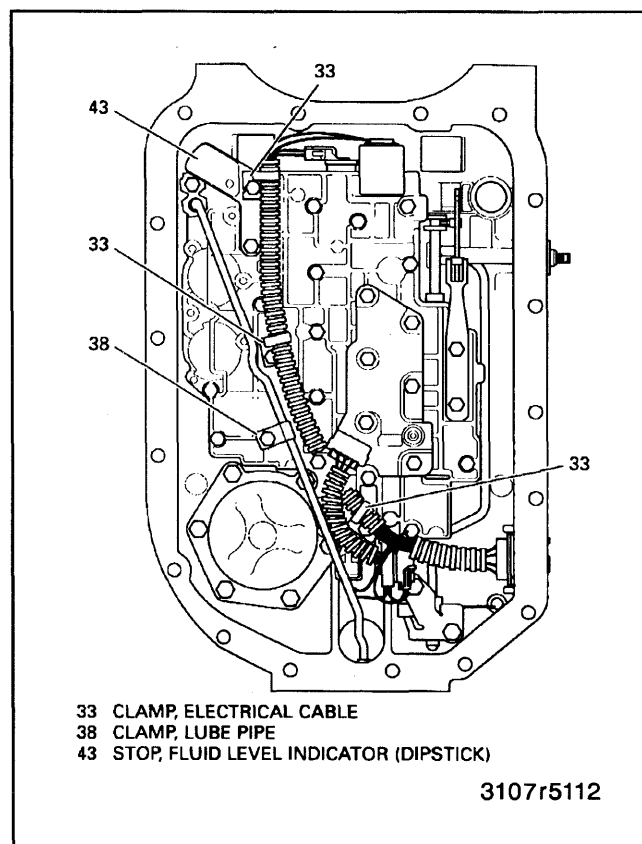


Figure 14—Wiring Harness Location



Install or Connect

1. New seal (57) onto the piston (58).
2. Front servo piston spring (60) and retainer (59).
3. Ring (56), piston pin (55), and piston (57).
 - Make certain the tapered end of the piston pin (55) contacts the band.
4. Front servo assembly into the case.

REAR SERVO REPLACEMENT



Remove or Disconnect (Figure 16)

1. Rear servo accumulator assembly (64 through 74).

BAND APPLY PIN CHECK FOR REAR SERVO ASSEMBLY



Measure (Figures 17, 18, and 19)

Tools Required:

J 21370-10 Gage Pin

J 38737 Band Apply Pin Checking Tool

NOTICE: For steps 3 and 5, refer to "Notice" on page 7A17B-1.

1. Place J 21370-10 in the servo bore.
2. Position J 38737 over the bore with the hex nut facing the parking pawl linkage.
3. Fasten with two rear servo cover bolts (61).

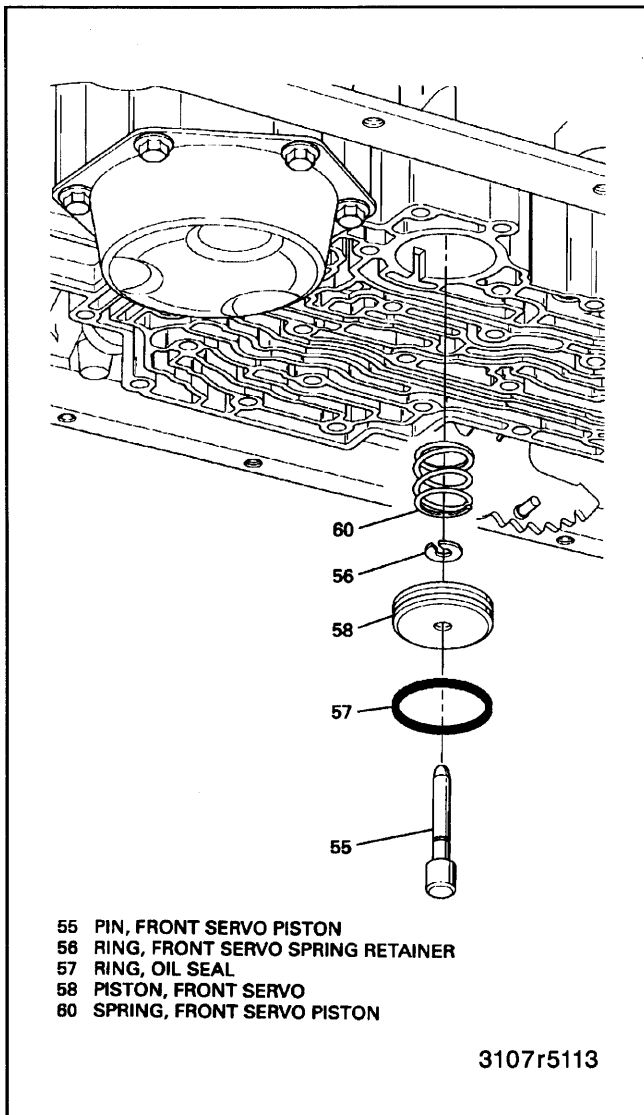


Figure 15—Front Servo Assembly



Tighten

- Bolts (61) to 24 N.m (18 lbs. ft.).

4. Make sure J 21370-10 moves freely in the tool and pin bore.
5. To determine the correct pin length, apply torque to the nut on the gage.



Tighten

- Nut to 34 N.m (25 lbs. ft.).

6. For pin selection, refer to figure 19.

REAR SERVO ACCUMULATOR



Disassemble (Figure 16)

- Retaining clip (64) from rear band apply pin (73) and inspect.

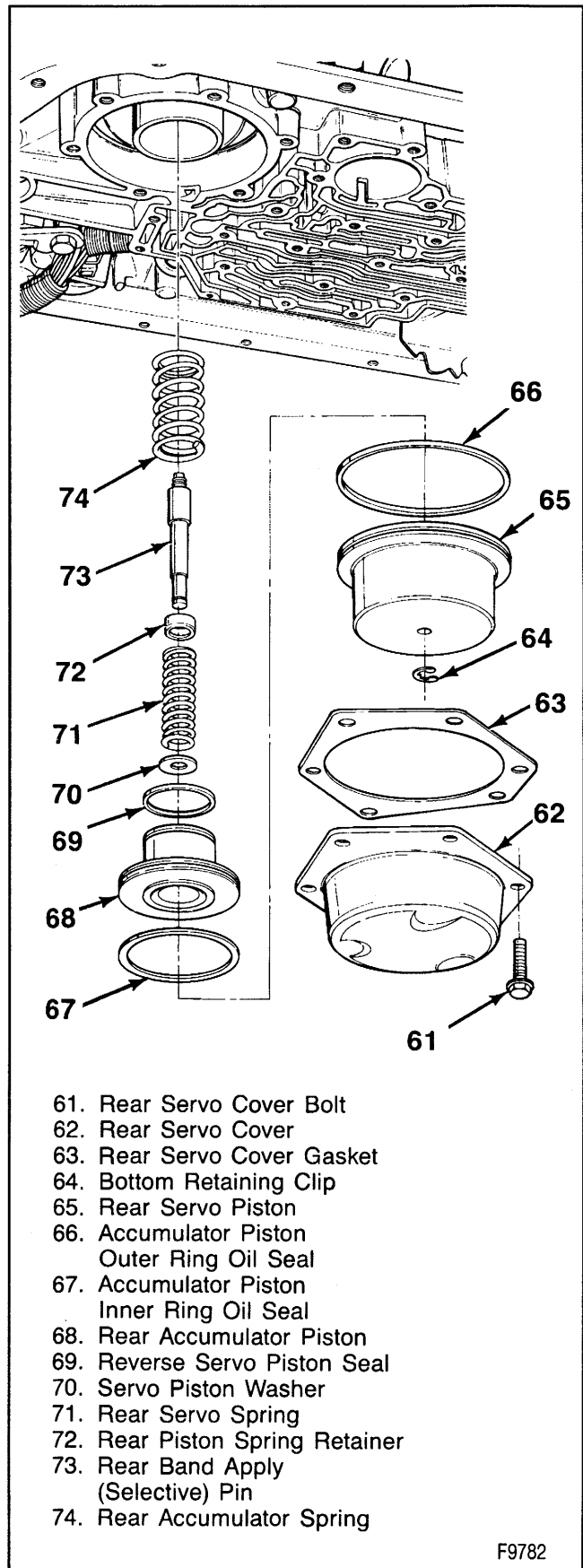


Figure 16—Rear Servo Assembly

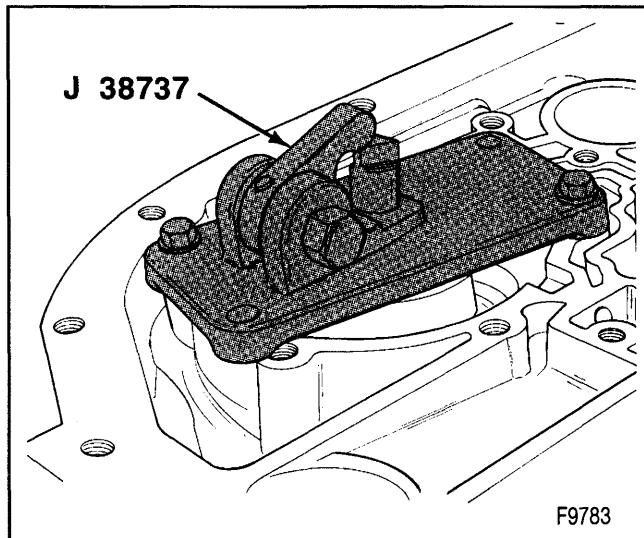


Figure 17—Band Apply Pin Checking Tool

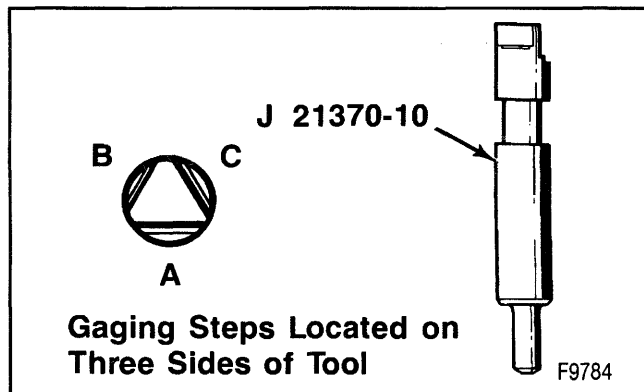


Figure 18—Gage Pin



Inspect

1. Rear accumulator piston (68) and rear servo piston (65) for:
 - Porosity or damage.
 - Ring groove for damage.
2. Seals (66, 67, and 68) for:
 - Nicks or cuts.
3. Cover (62) for:
 - Porosity or damage.
 - Scored or damaged.
4. Springs (71 and 74) for:
 - Distortion.
5. Pin (73) for:
 - Wear.
6. Servo bore for:
 - Wear or scoring.



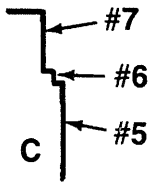
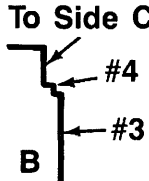
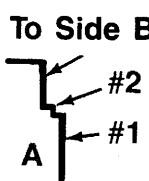
Clean

- All components.



Assemble

1. Rear servo spring retainer (72), rear servo spring (71), and servo washer (70) on rear band apply pin (73).

		7. PIN LENGTH	I.D.
		3.468" - 3.474"	
	#7		
	#6		
	#5		
6.		3.440" - 3.446"	
5.		3.412" - 3.418"	
	#4		
	#3		
4.		3.384" - 3.390"	
3.		3.356" - 3.362"	
	#2		
	#1		
2.		3.328" - 3.334"	
1.		3.300" - 3.306"	

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Figure 19—Band Apply Pin Selection Chart

2. Rear servo piston seal (66) and rear servo piston (65) and press onto rear band apply pin (73).
3. Retaining ring (64).
4. Lube seals, inner (69) and outer (67) before installing accumulator piston seals on accumulator piston (68). Place in rear servo piston.



Install or Connect

1. Rear accumulator spring (74) in case bore.

NOTICE: Refer to "Notice" on page 7A17B-1.

2. New gasket (63), cover (62), and six bolts (61) using a 10-mm socket.



Tighten

- Bolts (61) to 24 N.m (18 lb. ft.).

FILLER TUBE REPLACEMENT

↔ Remove or Disconnect (Figure 20)

1. Transmission dipstick.
2. Air cleaner.
3. Bolt from the tube bracket.
 - Raise the vehicle.
4. Filler tube from the transmission.
 - Pull filler tube up from the transmission.
5. Filler tube seal from the filler tube.

🧼 Clean

- Metal parts using solvent. Do not allow solvent to enter the transmission. Air dry.

↔ Install or Connect (Figure 20)

1. New filler tube seal into the transmission case.
2. Filler tube into the filler tube seal.

NOTICE: Refer to "Notice" on page 7A17B-1.

3. Tube bracket bolt.

🔧 Tighten

- Bolt 44 N.m (33 lbs. ft.).
 - Lower the vehicle.
4. Air cleaner.
 5. Transmission dipstick.

SPEED SENSOR REPLACEMENT

↔ Remove or Disconnect (Figure 3)

1. Two speed sensor bolts (23).
2. Two speed sensor and bracket assemblies (22) from the case.

👁 Inspect (Figure 3)

- Speed sensor assemblies (22) for evidence of damage.

↔ Install or Connect (Figure 3)

1. Two speed sensor and bracket assemblies (22) onto the case.

NOTICE: Refer to "Notice" on page 7A17B-1.

2. Two bolts (23), using an 8-mm socket.

🔧 Tighten

- Bolts (23) to 11 N.m (96 lbs. in.).
3. Case oil test plug (24) (if removed).

TRANSMISSION REPLACEMENT

If the transmission is being lowered for clearance, perform steps 1-9 only.

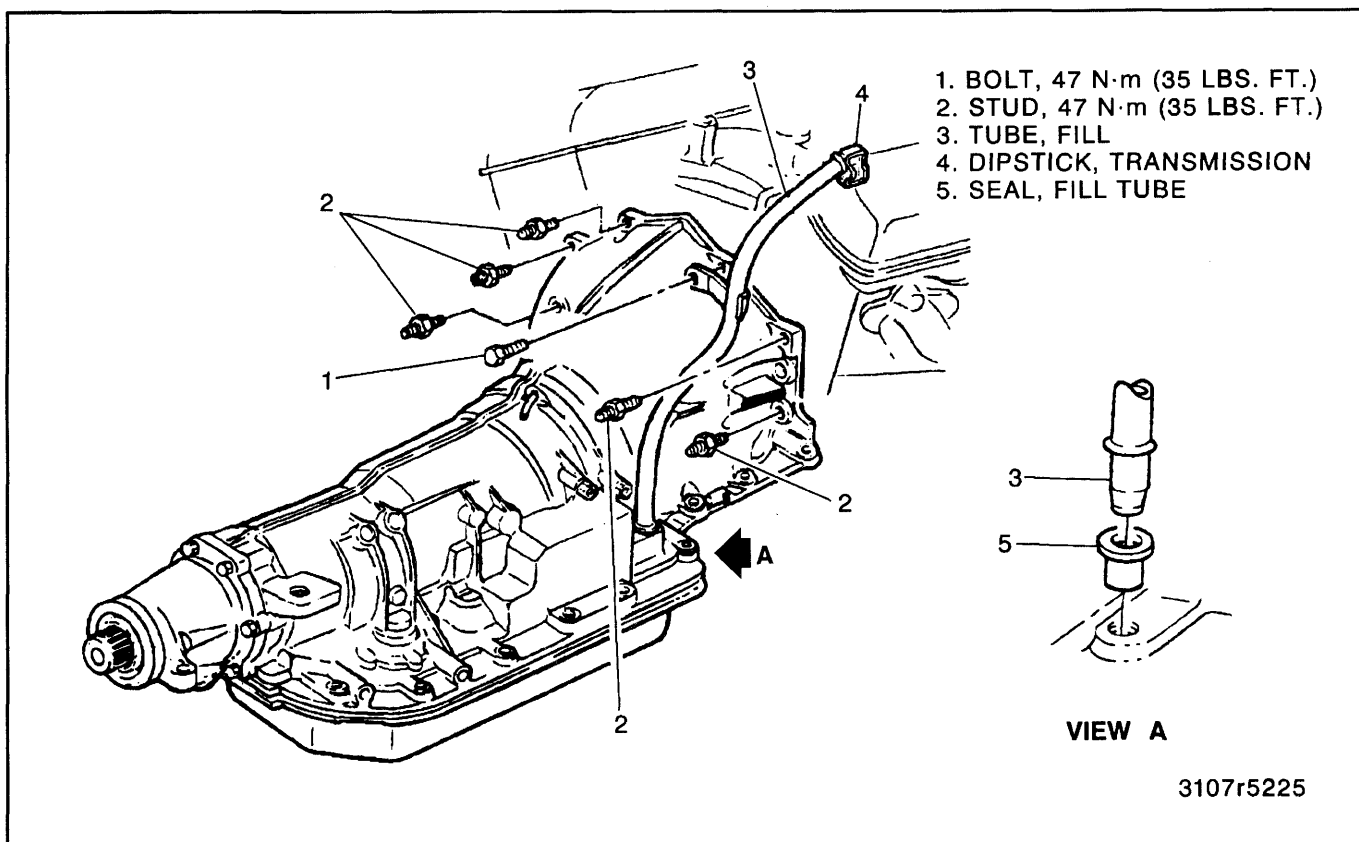


Figure 20—Filler Tube Replacement

↔ Remove or Disconnect (Figures 20 through 23)

Tool Required:

J 21366 Converter Holding Strap

1. Negative battery cable. Refer to SECTION 0A.
2. Air cleaner, if the transmission is being removed.
 - Raise the vehicle.
3. Transmission fluid.
4. Shift linkage.
5. Propeller shaft. Refer to SECTION 4A.
 - Front propeller shaft, if used, from the transfer case.
6. Fuel lines. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.
7. The support bracket at the catalytic converter.
 - Any other components as needed for clearance.
 - Support the transmission and the transfer case, if used, with a transmission jack.
8. Transmission crossmember.

! Important

- Do not stretch or damage any cables, wires, or other components when lowering the transmission.
9. Transmission far enough for clearance to reach other components.
 10. Dipstick tube and the seal.
 - Cover the opening in the transmission.
 11. Electrical connectors from the transmission (figure 23).
 12. Cooler lines (figure 22).

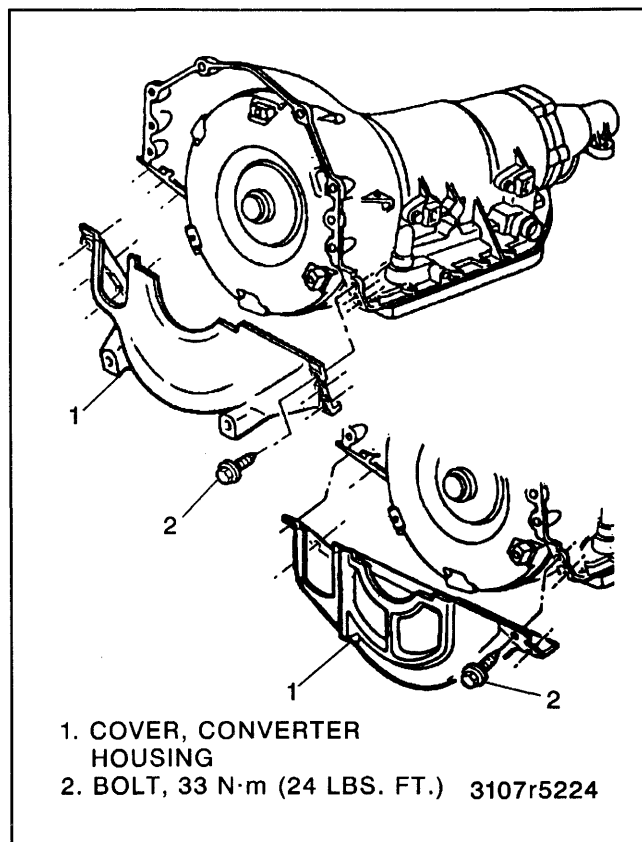


Figure 21—Converter Housing Cover

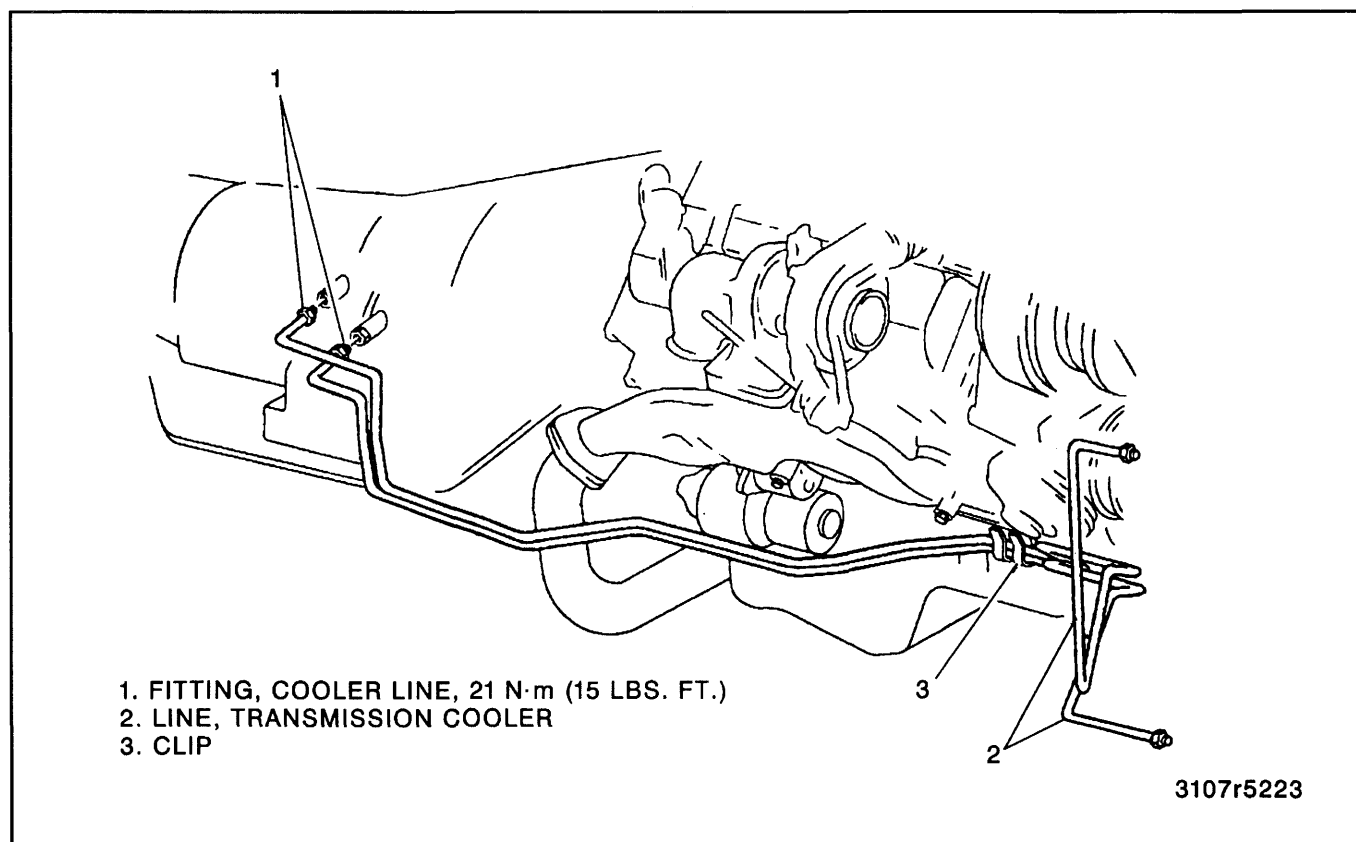


Figure 22—Transmission Cooler Lines

7A17B-18 4L80-E ON-VEHICLE SERVICE

- Cap all openings in the transmission and the lines.
13. Transfer case shifter and move it aside. Refer to SECTION 7D.
 14. Transmission support braces.
 - Note the location of the braces, they must be installed in the same positions.
 15. Converter housing cover (figure 21).
 - Mark the flywheel and the torque converter alignment.
 16. Flywheel to torque converter bolts.



Important

- Support the engine with a jack or hoist before disconnecting the transmission.
17. Transmission housing to the engine bolts.
 - Note the location of any brackets or clips and move them aside.
 - Slide the transmission straight back of the locating pins (A) and install J 21366.
 18. Transmission from the vehicle.



Clean

- Transmission case using a solvent dampened cloth, do not allow solvent to enter the transmission. Air dry.
- All hardware and flywheel cover using solvent. Air dry.



Inspect

- All parts for wear and damage.
- All seals and fittings for signs of leakage.
- Torque converter for stripped or broken weld nuts or screw holes.
- Transmission case for porosity.



Install or Connect (Figures 20 through 23)

NOTICE: For steps 2, 3, and 9, refer to "Notice" on page 7A17B-1.

If the transmission was lowered for clearance only, perform steps 12-18.

Tool Required:

J 21366 Converter Holding Strap

1. Transmission to the vehicle.
 - Be sure the torque converter is seated properly and J 21366 is in place.
 - Support the transmission, and the transfer case if used, with a transmission jack.
 - Raise the transmission into place and remove J 21366.
 - Slide the transmission straight onto the locating pins (A) while lining up the marks on the flywheel and the torque converter.



Important

- The torque converter must be flush onto the flywheel and rotate freely by hand.

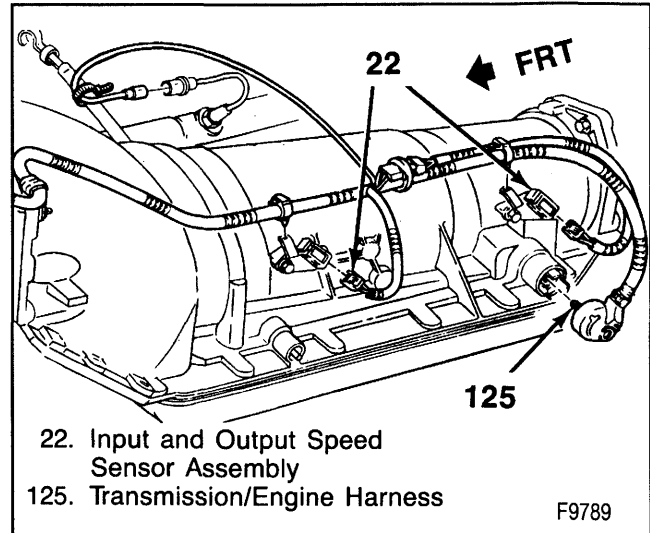


Figure 23—Transmission Exterior Electrical Connections

2. Transmission to the engine bolts.
 - All brackets, clips, and harnesses must be positioned as they were when removed.
 - Do not install the dipstick tube or the transmission support brace screws.
3. Flywheel to the torque converter bolts.



Tighten

- Screws finger tight to insure proper converter seating.
 - Torque converter bolts to 63 N.m (46 lbs. ft.).
 - Remove the engine hoist or jack.
4. Converter housing cover (figure 21).
 - Hook the cover under the lip of the engine oil pan.
 5. Transmission support braces.
 - The braces must be installed in the positions from which they were removed.
 6. Transfer case shifter, if used. Refer to SECTION 7D.
 7. Cooler lines (figure 22).
 - Uncover the openings.
 - Do not twist or bend the lines.
 8. Electrical connectors to the transmission (figure 23).
 - Uncover the opening and install the seal first.
 9. Dipstick tube with a new seal (figure 20).
 - Install bolt.



Tighten

- Bolt to 44 N.m (33 lbs. ft.).
10. Transmission in place.



Important

- Do not pinch or damage any cables, wires, or other components when raising the transmission.
11. Transmission crossmember and the transmission mount.

- Any components that were removed for clearance.
 - Remove the transmission jack.
12. The support bracket at the catalytic converter.
 13. Fuel lines. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.
 14. Propeller shaft. Refer to SECTION 4A.
 - Front propeller shaft to the transfer case, if used.
 15. Shift linkage.
 - Lower the vehicle.
 16. New transmission fluid.
 17. Air cleaner, if removed.
 18. Negative battery cable.

TRANSMISSION COOLER FLUSHING

Transmission oil cooler flushing must be performed whenever a transmission is removed for service. It is essential to flush the oil cooler after transmission installation, a major overhaul, if fluid contamination is suspected, or in any case of pump or torque converter replacement.

To ensure complete transmission system service, perform the flush procedure after the overhauled or replacement assembly has been reinstalled in the vehicle.

Tools Required:

- J 35944 Cooler Flushing Tool
- J 35944-20 or J 35044-CSE Biodegradable Flushing Solution

Preparation

1. After overhauled or service replacement transmission is reinstalled in vehicle, do not reconnect oil cooler pipes.
2. Remove fill cap on J 35944 and fill can with 0.6 liter (20-21 ounces) of flushing solution. Do not overfill or tool will need to be recharged with air before backflush. Follow manufacturer's suggested procedures for proper handling of solution.

NOTICE: Do not substitute with any other solution. The flushing tool is designed to use only this concentrate. Use of any solution can result in damage to the tool, cooler components, or improper flushing of the cooler.

3. Secure fill cap and pressurize the flusher can with shop air to 550-700 kPa (80-100 psi).

CAUTION: Shop air supply must be equipped with a water/oil filter and not exceed 825 kPa (120 psi), or personal injury may result.

4. Connect the discharge hose to the transmission end of the oil cooler pipe that goes to the top fitting at the radiator.
5. Clip discharge hose onto the oil drain container.
6. Mount the flushing tool to undercarriage of vehicle with the hook provided and connect the hose from the flushing tool to the remaining oil cooler pipe.
7. With the water valve on the tool in the off position, connect the water hose from the water supply to the tool.

8. Turn on the water supply at the faucet.

Initial Flush

9. Switch the water valve on the tool to the on position. Allow the water to flow through the oil cooler for 10 seconds to remove the supply of transmission fluid in the system.

CAUTION: If water does not flow through the oil cooler (system is completely plugged), do not continue flushing procedure. Turn the water off immediately and inspect the pipes and cooler for restrictions and repair, or personal injury could result.

10. Switch the water valve on the tool to the off position and clip the discharge hose onto a 5-gallon pail with a lid, or place a shop towel over the end of the discharge hose to prevent splash. Discharge will foam vigorously when solution is introduced into water stream.
11. Switch the water valve on the tool to the on position and depress the trigger to mix flushing solution into the water flow. Use the bale clip provided on the handle to hold the trigger down.
12. Flush oil cooler with water and solution for 2 minutes. During this flush, attach the air supply to the air valve located on plumbing of tool for 3 to 5 seconds at the end of every 15-20 second interval to create a surging action.
13. Release the trigger and switch the water valve on the tool to the off position.
14. Disconnect both hoses from the oil cooler pipes.

Backflush

15. Connect hoses to the oil cooler pipes opposite from the initial flush procedures to perform a backflush.
16. Repeat steps 11 and 12.
17. Release the trigger and allow water only to rinse the oil cooler for 1 minute.
18. Switch the water valve on the tool to the on position and turn the water supply off at the faucet.
19. Attach the air supply to the air valve located on the plumbing of the tool and dry the system out with air for at least 2 minutes. If moisture is visible exiting from the oil cooler line discharge hose, use an air chuck clip, if available, to secure the air chuck onto the air valve for ease of operation.

NOTICE: Excessive residual moisture can cause corrosion in the oil cooler or cooler pipes and can damage the transmission. If steps 20 through 23 cannot be completed at this time, rinse the oil cooler and cooler pipes with transmission fluid. Complete steps 20 through 23 after reinstallation of transmission.

20. Connect the cooler feed pipe to the transmission top connector.
21. If not already connected, attach the discharge hose to the cooler return pipe (bottom connector) and place into an appropriate drain container.
22. After filling the transmission with automatic transmission fluid, start the engine and run for 30 seconds. This will remove any residual moisture from

the oil cooler and cooler pipes, protect all components from corrosion, and check flow rate through the cooler. A minimum of 2 quarts must be obtained during this 30-second run. If fluid flow is insufficient, check the fluid flow out of the transmission by disconnecting the oil cooler feed line at the radiator and restarting the engine.

Do the following according to flow rate:

- Insufficient Feed Flow: Inspect the transmission for cause.
 - Sufficient Feed Flow: Inspect oil cooler pipes and fittings for restrictions or leaks and repeat the oil cooler flushing procedure. Repeat the check of fluid flow out the return line. If flow is still inhibited, replace the oil cooler.
23. Remove discharge hose, reconnect cooler return pipe to transmission and refill unit to proper fluid level.

Tool Cleaning - Every Third Use

24. Disconnect the water supply hose from the tool.
25. Bleed the air pressure from the can, remove the fill cap, return any unused solution to the container, and rinse the can out with water. Do not store the tool with solution in the tank.

Tool Cleaning - Every Third Use

26. Loosen large coupling nut and remove plumbing from the tank.
27. Remove the screen from the plumbing and wash with water.
28. Use the cleaning pin to remove any material in the solution orifice. Orifice is located in the plumbing below the screen.
29. Reconnect the plumbing and fill the can half way with water, secure the fill cap, and pressurize the can to 550-700 kPa (80-100 psi).
30. Aim tool into the 5 gallon pail or floor drain and depress the trigger to allow water from the can to flow through the solution orifice for 30 seconds to ensure proper cleaning.
31. Bleed air pressure from can, remove the fill cap, and empty the can.
32. Reconnect fill cap flushing tool.

SHIFT INDICATOR REPLACEMENT AND ADJUSTMENT

Refer to SECTION 8C.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR REPLACEMENT

↔ Remove or Disconnect (Figure 24)

Other than checking for loose hoses and electrical connections, the only service possible is unit replacement, if diagnosis shows the sensor to be faulty.

↔ Remove or Disconnect

1. Battery negative cable. Refer to SECTION 8C.
2. Vacuum harness assembly.
3. Electrical connector releasing locking tab.
4. Bolts or release lock tabs and remove sensor.

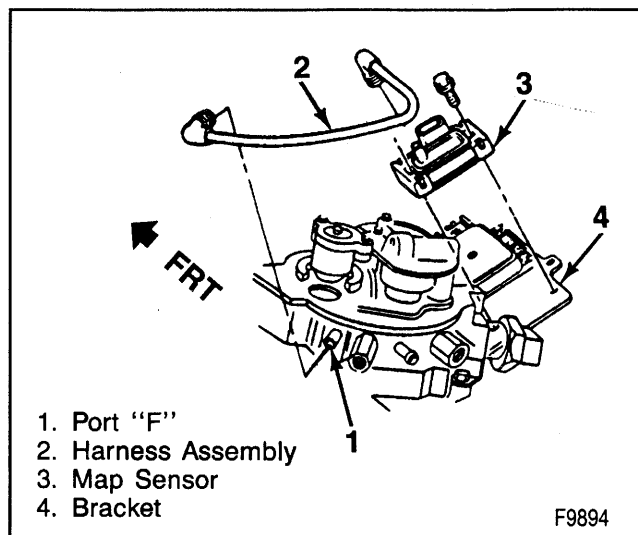


Figure 24—Manifold Absolute Pressure MAP Sensor

↔ Install or Connect (Figure 24)

NOTICE: Refer to "Notice" on page 7A17B-1.

1. Bolts or snap sensor on bracket.
2. Electrical connector.
3. Vacuum harness.
4. Battery negative cable.

THROTTLE POSITION (TP) SENSOR REPLACEMENT

↔ Remove or Disconnect (Figure 25)

NOTICE: The TP sensor is an electrical component and must not be soaked in any liquid cleaner or solvent, as damage may result.

! Important

- On all of the V-8 engines, the TP sensor is non-adjustable without retainers. In addition, on the 7.4L (V-8) engines, the TP sensor has a horizontal electrical connector. On all other engines, the connector is vertical.

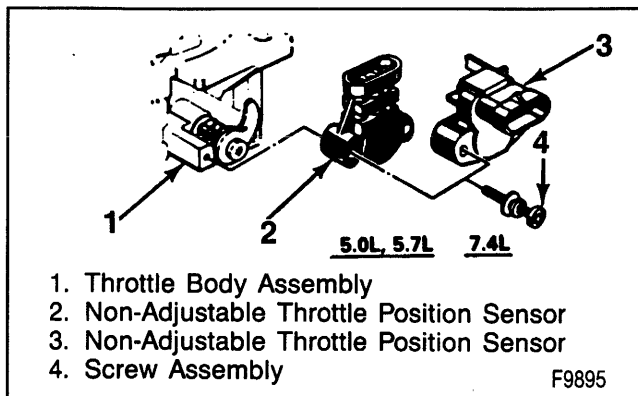


Figure 25—TP Sensor



Remove or Disconnect (Figure 25)

1. Air cleaner, adapter, and gaskets. Discard gaskets.
2. Electrical connector releasing locking tab.
3. Two TP sensor attaching screw assemblies and retainers (if applicable).
4. TP sensor from the throttle body assembly.



Install or Connect (Figure 25)

1. TP sensor on the throttle body assembly, while lining up the TP sensor lever with the TP sensor drive lever on the throttle body.

NOTICE: Refer to "Notice" on page 7A17B-1.



Tighten

- Screws to 2.0 N·m (18 lbs. in.).
- 2. Electrical connector.
- 3. Air cleaner, adapter, and new gaskets.

SPECIFICATIONS

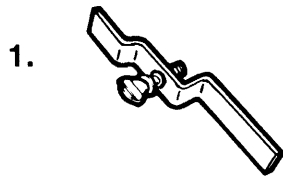
FASTENER TIGHTENING SPECIFICATIONS

	N·m	Lbs. Ft.	Lbs. In.
Accumulator Housing to Valve Body	11		96
Case Extension to Case Bolt	34	25	—
Control Valve Assembly to Case Screw	11		96
Cooler Line Fittings	38	28	—
Engine Rear Mount to Transmission Bolt	44	33	—
Engine Rear Support Bracket to Frame Unit	44	33	—
Flywheel Housing Cover to Transmission Bolt	7	—	60
Flywheel to Converter Bolt	44	33	—
Force Motor Bracket-to-Valve Body Screw	9		72
Oil Pan to Case Bolt	24	18	—
Oil Test Hole Plug	11	—	96
Parking Pawl Bracket to Case Bolt	24	18	—
Rear Servo Cover to Case Bolt	24	18	—
Shift Linkage			
Bracket to Frame Bolt	26	19	—
Shift Lever to Transmission Nut	30	20	—
Swivel to Equalizer Lever Bolt	28	20	—
Solenoids to Valve Body Screw	10		72
Speed Sensor to Case	11		96
Temperature Sensor-to-Valve Body	5		48
Transmission Case to Engine Bolt	44	33	—
Transmission Oil Dipstick Tube Bolt	44	33	—
Valve Body to Case Lube Pipe	11		96
Valve Body to Case PSM	11		96

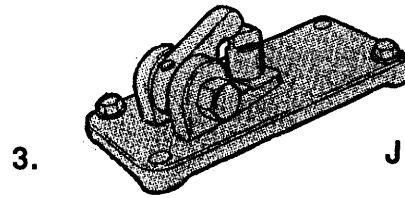
LUBRICATION SPECIFICATIONS

Overhaul 4L80E	12.8L	13.5 pts.
Pan Removal 4L80E	7.3L	7.7 pts.
Type Recommended	DEXRON®3 or DEXRON®II E T2620	

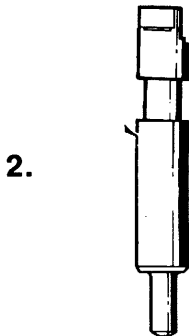
SPECIAL TOOLS



J 21366



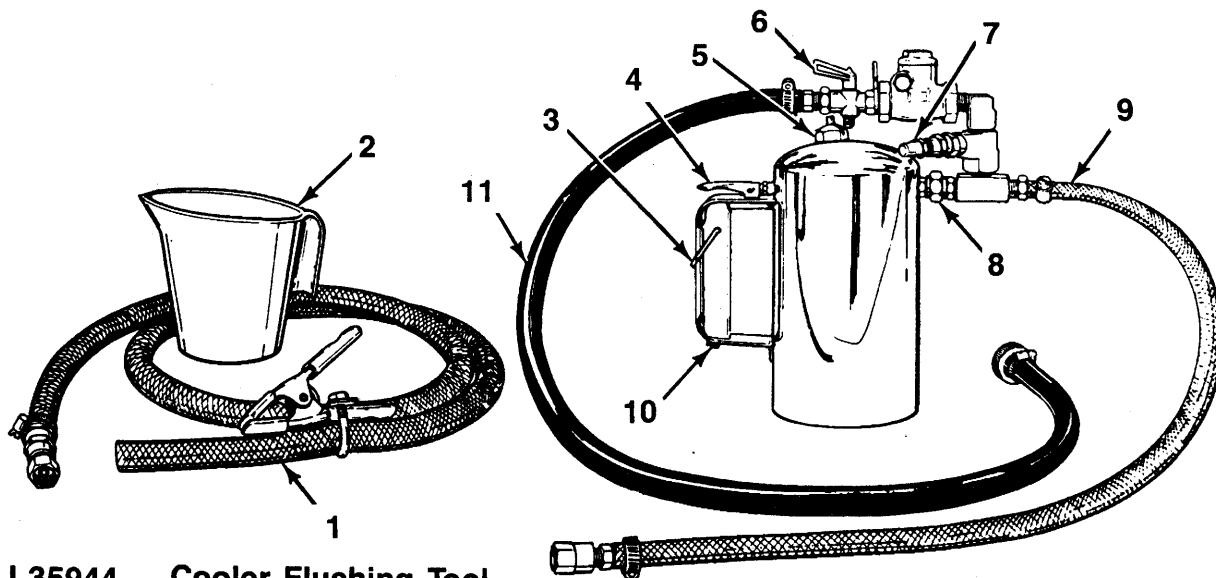
J 38737



J 21370-10

- 1. Converter Holding Strap
- 2. Band Apply Pin Gauge
- 3. Band Apply Pin Checking Tool

F9896



J 35944 Cooler Flushing Tool

- 1. Discharge Hose
- 2. Measuring Cup
- 3. Bale Clip
- 4. Trigger to Introduce Solution
- 5. Fill Cap and Tank
- 6. Water Valve (On-Off)
- 7. Air Valve to Surge Lines
- 8. Large Coupling Nut
- 9. Water and Solution Feed Hose
- 10. Cleaning Pin
- 11. Water Supply Hose

F9771

SECTION 7A17C

**4L80-E AUTOMATIC TRANSMISSION
DIAGNOSTIC CODES**

For information about the 4L80-E automatic transmission diagnostic codes, refer to the Driveability, Emission, and Electrical Diagnosis Manual for these models.

7A17C-2 4L80-E AUTOMATIC TRANSMISSION DIAGNOSTIC CODES

SECTION 7B

MANUAL TRANSMISSION

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

NEW VENTURE GEAR 4500

The New Venture Gear 4500 five-speed manual transmission provides synchronized shifting in all forward gears and constant mesh helical gearing for reduced noise.

Other features include an overspeed inhibitor from low to first gears, dual cone low, and first gear synchronizer.

NEW VENTURE GEAR 3500

The five-speed 85 mm overdrive transmission has a diecast aluminum case. The transmission gears are in constant mesh and all forward speeds are fully synchronized.

Gear shifting is done with a shift tower mounted shift lever.

DIAGNOSIS

Before repairing the transmission, check the clutch and shifting linkages to be sure the problem is in the transmission.

TRANSMISSION MOUNT

1. Raise the vehicle and try to move the extension housing up and down.
2. If the plate is loose on the crossmember, tighten the bolts.

3. If the rubber is split or spongy, replace the mount.

CLUTCH SPINDOWN TIME

1. Run the engine at a normal idle with the transmission in neutral and the clutch engaged.
2. Disengage the clutch, wait 9 seconds, and shift the transmission into reverse.
3. If a grinding noise is heard, check the clutch for the problem. Refer to SECTION 7C.

DIAGNOSIS OF MANUAL TRANSMISSION

PROBLEM	POSSIBLE CAUSE	CORRECTION
Transmission Shifts Hard	1. Shift rail binding 2. Internal bind in the transmission caused by shift forks, selector plates, or synchronizer assemblies. 3. Incorrect lubricant.	1. Check for mispositioned selector arm roll pin, loose cover bolts, worn shift rail bores, worn shift rail, distorted oil seal, or extension housing not aligned with the case. Repair as necessary. 2. Remove, disassemble, and inspect the transmission. Replace worn or damaged components as necessary. 3. Drain and refill the transmission.
Gear Clash When Shifting From One Gear To Another	1. Lubricant level low or incorrect lubricant. 2. Gearshift components, or synchronizer assemblies worn or damaged. 3. Clutch not fully disengaging.	1. Drain and refill the transmission and check for lubricant leaks if the level was low. Repair as necessary. 2. Remove, disassemble and inspect the transmission. Replace worn or damaged components as necessary. 3. Refer to Section 7C.
Transmission Noisy	1. Lubricant level low or incorrect lubricant. 2. Clutch housing-to-engine, or transmission-to-clutch housing bolts loose. 3. Gearshift mechanism, transmission gears, or bearing components worn or damaged. 4. Worn pilot bearing.	1. Drain and refill the transmission. If lubricant level was low, check for leaks and repair as necessary. 2. Check and correct bolt torque as necessary. 3. Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary. 4. Refer to Section 7C.
Jumps Out Of Gear	1. Gearshift mechanism, shift forks, selector plates, selector assembly, shift rail, springs or shift cover worn or damaged. 2. Gear teeth worn or tapered, synchronizer assemblies worn or damaged, excessive end play caused by worn thrust washers or output shaft gears.	1. Remove and inspect the transmission cover assembly. Replace worn or damaged cover assembly. 2. Remove, disassemble, and inspect the transmission. Replace worn or damaged components as necessary.
Will Not Shift Into One Gear	1. Gearshift selector plates or selector assembly, worn, damaged, or incorrectly assembled. 2. Synchronizer sleeves or hubs damaged or worn.	1. Remove, disassemble, and inspect the transmission cover assembly. Repair or replace components as necessary. 2. Remove, disassemble, and inspect the transmission. Replace worn or damaged components.
Locked In One Gear—Cannot Be Shifted Out	1. Shift rail(s) worn or broken, shifter fork bent or worn. 2. Gearshift lever worn, shift mechanism in the cover incorrectly assembled or broken, worn or damaged gear train components.	1. Inspect and replace worn or damaged parts. 2. Disassemble the transmission. Replace damaged parts or assemble correctly.

D0312

ON-VEHICLE SERVICE

DRAIN AND FILL

Remove or Disconnect

- Raise the vehicle.
- 1. Filler plug.
- 2. Drain plug or the lower PTO cover bolt (4500 models).
- 3. Transmission oil.
 - Catch the oil in a suitable container.

Install or Connect

NOTICE: For steps 1 and 3, refer to "Notice" on page 7B-1.

1. Drain plug or lower PTO cover bolt (4500 models).

Tighten

- PTO cover bolt to 41 N.m (30 lbs. ft.) (New Venture Gear 4500 models).
- Drain plug to 60 N.m (46 lbs. ft.) (New Venture Gear 3500 models).
- 2. New transmission oil.
 - Fill to the level of the fill plug hole. Refer to "Specifications."
- 3. Filler plug.

Tighten

- Filler plug to 41 N.m (30 lbs. ft.) (New Venture Gear 4500 models).
- Filler plug to 60 N.m (46 lbs. ft.) (New Venture Gear 3500 models).
- Lower the vehicle.

SHIFT CONTROL LEVER REPLACEMENT

Remove or Disconnect (Figures 1 and 2)

1. Shift boot retainer screws and the retainer.
2. Shift boot screws.
3. Transmission shift control lever boot.
4. Insulator.
5. Control lever.

Install or Connect (Figures 1 and 2)

NOTICE: For steps 4 and 5, refer to "Notice" on page 7B-1.

1. Control lever.
2. Insulator.
3. Transmission shift control lever boot.
4. Shift boot screws.

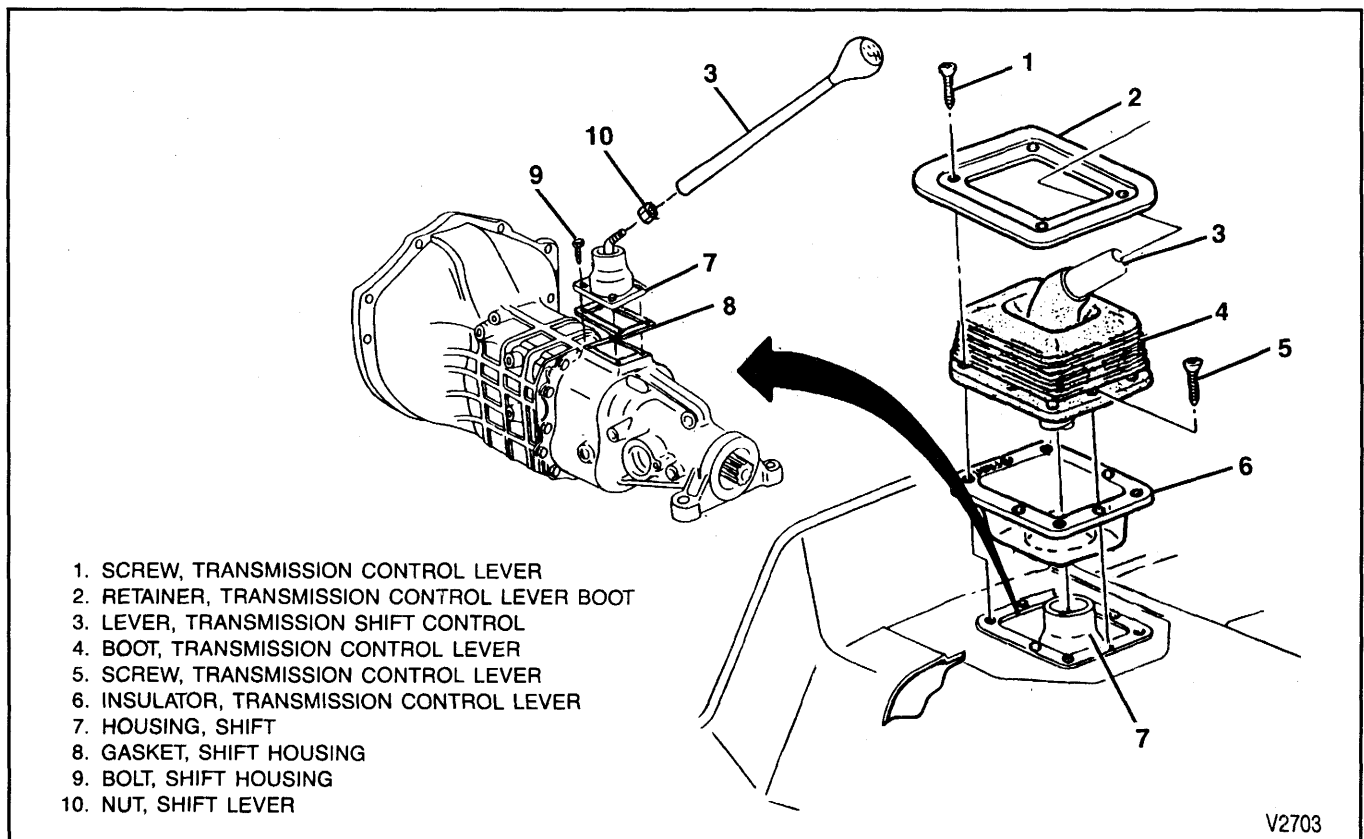
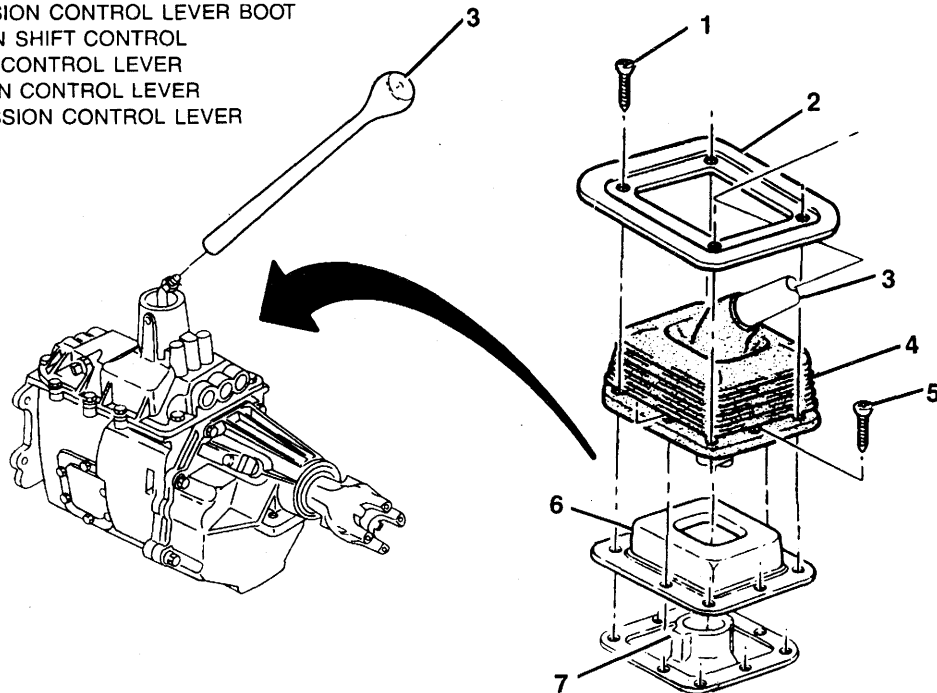


Figure 1—Shift Lever and Boot (New Venture Gear 3500 Transmission)

V2703

7B-4 MANUAL TRANSMISSION

1. SCREW, TRANSMISSION CONTROL LEVER
2. RETAINER, TRANSMISSION CONTROL LEVER BOOT
3. LEVER, TRANSMISSION SHIFT CONTROL
4. BOOT, TRANSMISSION CONTROL LEVER
5. SCREW, TRANSMISSION CONTROL LEVER
6. INSULATOR, TRANSMISSION CONTROL LEVER
7. HOUSING, SHIFT



V2704

Figure 2—Shift Lever and Boot (New Venture Gear 4500 Transmission)



Tighten

- Screws to 1.9 N.m (17 lbs. in.).

5. Shift boot retainer and screws.



Tighten

- Screws to 1.9 N.m (17 lbs. in.).

VEHICLE SPEED SENSOR REPLACEMENT



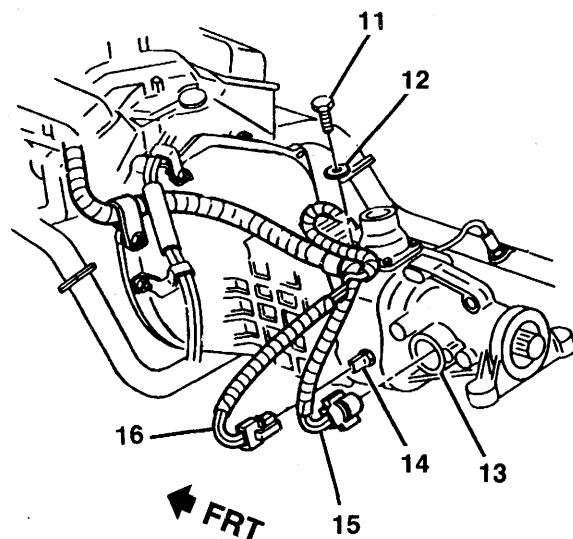
Remove or Disconnect (Figures 3 and 4)

- Raise the vehicle.
- 1. Harness connector from the vehicle speed sensor.
- 2. Bolt, if used.
 - Place drain pan under transmission to catch fluid.
- 3. Speed sensor from the transmission.
- 4. O-ring seal.



Install or Connect (Figures 3 and 4)

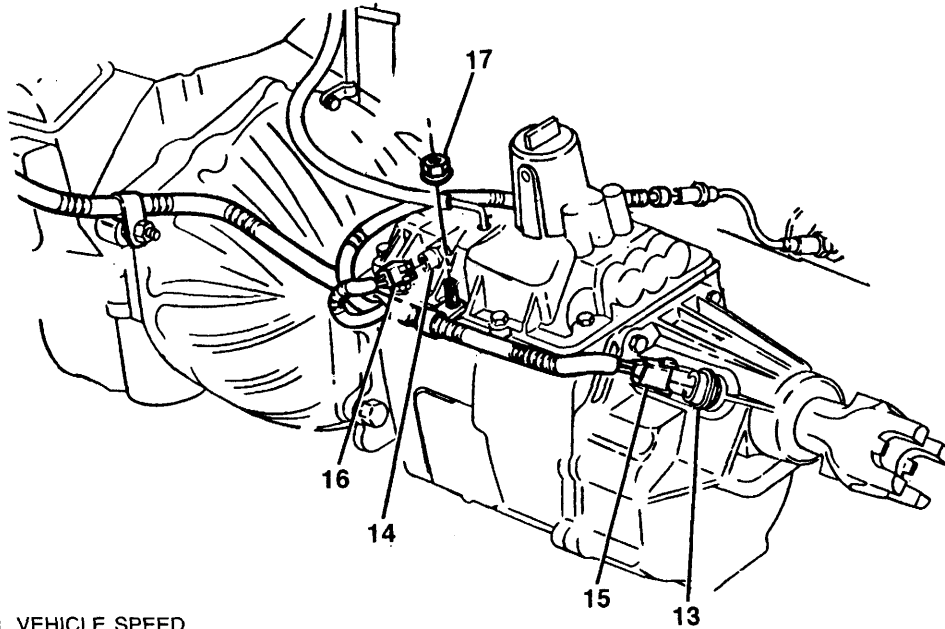
- 1. New O-ring seal.
 - Coat the seal with a thin film of transmission oil.
- 2. Speed sensor.
- 3. Bolt, if used.
- 4. Harness connector to the vehicle speed sensor.
 - Lower the vehicle.



11. BOLT, ELECTRICAL HARNESS
12. WASHER, ELECTRICAL HARNESS
13. SENSOR, VEHICLE SPEED
14. SWITCH, BACKUP LAMP
15. CONNECTOR, ELECTRICAL HARNESS
16. CONNECTOR, ELECTRICAL HARNESS

V2705

Figure 3—Vehicle Speed Sensor (New Venture Gear 3500 Transmission)



- 13. SENSOR, VEHICLE SPEED
- 14. SWITCH, BACKUP LAMP
- 15. CONNECTOR, ELECTRICAL HARNESS
- 16. CONNECTOR, ELECTRICAL HARNESS
- 17. NUT, ELECTRICAL HARNESS

V2706

Figure 4—Vehicle Speed Sensor (New Venture Gear 4500 Transmission)

BACKUP LAMP SWITCH REPLACEMENT

Remove or Disconnect (Figures 3 and 4)

- Raise the vehicle.
- 1. Harness connector from the backup lamp switch.
- 2. Backup lamp switch.
- 3. O-ring seal.

Install or Connect (Figures 3 and 4)

- 1. New O-ring seal.
- Coat new seal with thin film of transmission fluid.

NOTICE: Refer to "Notice" on page 7B-1.

- 2. Backup lamp switch.

Tighten

- Backup lamp switch to 28 N·m (21 lbs. ft.).
- 3. Harness connector to the backup lamp switch.
- Lower the vehicle.

EXTENSION OIL SEAL REPLACEMENT

NEW VENTURE GEAR 3500 TRANSMISSION

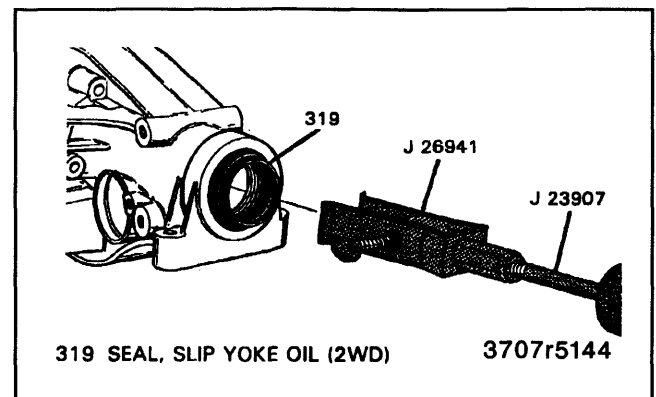
Two-Wheel Drive Models

Remove or Disconnect (Figure 5)

Tools Required:

- J 23907 Universal Slide Hammer
- J 26941 Output Shaft Seal Remover

- Raise the vehicle.
- 1. Transmission oil. Refer to "Drain and Fill."
- 2. Propeller shaft. Refer to SECTION 4A.
- 3. Seal, using J 23907 and J 26941 (figure 5).



**Figure 5—Extension Housing Seal Removal
(2WD Models)**

7B-6 MANUAL TRANSMISSION

Install or Connect (Figure 6)

Tool Required:

J 36503 Extension Housing Seal Installer

1. New seal, using J 36503 (figure 6).
 - Fill between the seal lips with chassis grease.
2. Propeller shaft. Refer to SECTION 4A.
3. New transmission oil. Refer to "Drain and Fill."
 - Lower the vehicle.

Four-Wheel Drive Models

Remove or Disconnect (Figure 7)

Tools Required:

J 23907 Universal Slide Hammer

J 36825 Output Shaft Seal Remover

- Raise the vehicle.
1. Transmission oil. Refer to "Drain and Fill."
 2. Propeller shaft. Refer to SECTION 4A.
 3. Seal, using J 23907 and J 36825 (figure 7).

Install or Connect (Figure 8)

Tool Required:

J 36502-A Extension Housing Seal Installer

- Install seal protector J 36502-2A onto output shaft.

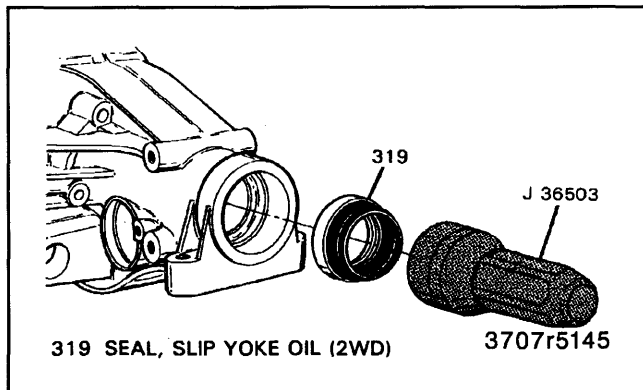


Figure 6—Extension Housing Seal Installation (2WD Models)

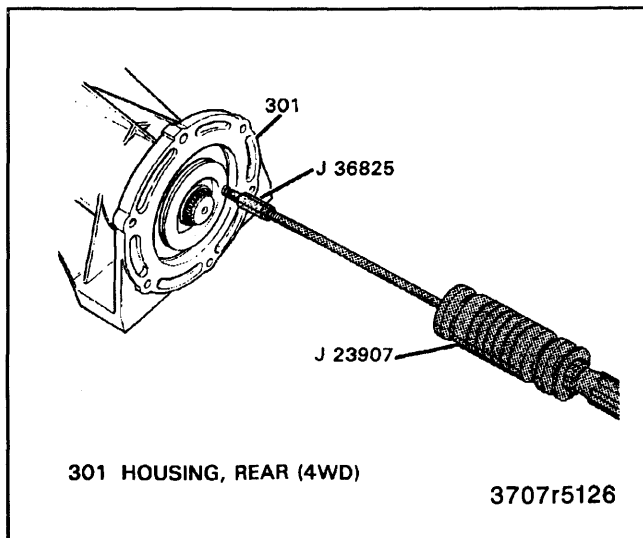


Figure 7—Extension Housing Seal Removal (4WD Models)

1. New seal, using J 36502-1 (figure 8).
 - Fill between the seal lips with chassis grease.
 - Remove seal protector J 36502-2A.
2. Propeller shaft. Refer to SECTION 4A.
3. New transmission oil. Refer to "Drain and Fill."
 - Lower the vehicle.

NEW VENTURE GEAR 4500 TRANSMISSION

Remove or Disconnect (Figure 9)

- Raise the vehicle.
1. Transmission oil. Refer to "Drain and Fill."
 2. Propeller shaft. Refer to SECTION 4A.
 3. Parking brake, if used. Refer to SECTION 5F.
 4. Yoke nut and washers.
 5. Yoke.
 6. Seal.

Install or Connect (Figure 9)

Tool Required:

J 22834 Extension Housing Seal Installer

1. New seal, using J 22834.
2. Yoke.

NOTICE: Refer to "Notice" on page 7B-1.

3. Washers and yoke nut.

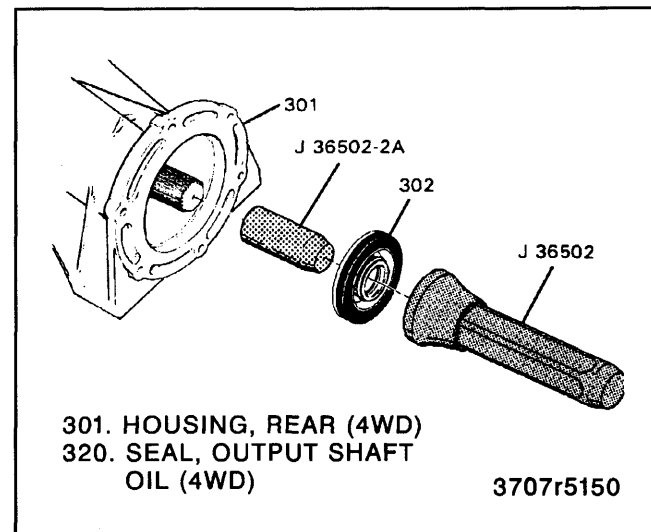


Figure 8—Extension Housing Seal Installation (4WD Models)

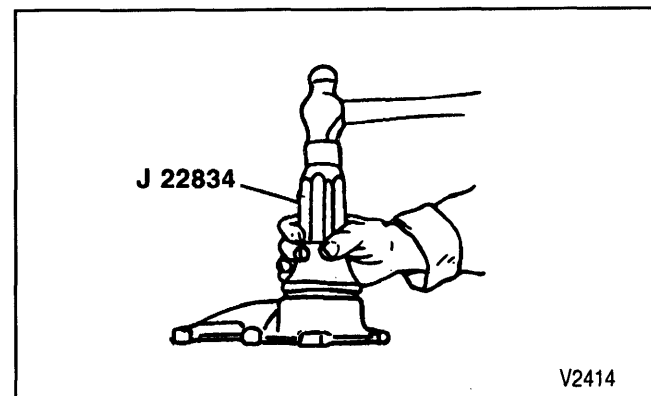


Figure 9—Extension Housing Seal Installation

V2414



Tighten

- Yoke nut to 441 N.m (325 lbs. ft.).
- 4. Parking brake, if used. Refer to SECTION 5F.
- 5. Propeller shaft. Refer to SECTION 4A.
- 6. Transmission oil. Refer to "Drain and Fill."
- Lower the vehicle.

TRANSMISSION REPLACEMENT



Remove or Disconnect (Figures 10, 11 and 12)

1. Shift control lever, as used. Refer to "Shift Control Lever Replacement."
 - Raise the vehicle.
2. Transmission oil. Refer to "Drain and Fill."
3. Propeller shaft. Refer to SECTION 4A.
4. Transfer case, if used. Refer to SECTION 7D.
5. Parking brake and controls, if used. Refer to SECTION 5F.
6. Exhaust pipes, if necessary. Refer to SECTION 6F.
7. Electrical harnesses, as necessary.
8. Clutch slave cylinder and lay it aside. Refer to SECTION 7C.
9. Bolts and the inspection cover (3500 transmission).
10. Transmission vent hose (4500 transmission).



Important

- Note the positions of any lines or wires before removing them.
 - Support the transmission with a jack.
11. Crossmember.
 12. Transmission to the clutch housing bolts and washers, as used.
 13. Transmission.



Important

- Do not let the transmission hang from the clutch.
- Pull the transmission straight back on the clutch hub splines.



Install or Connect (Figures 10, 11, and 12)

NOTICE: For steps 2 and 4, refer to "Notice" on page 7B-1.

- Shift the transmission into "Neutral" before installing.

1. Transmission.



Important

- Do not force the transmission into the clutch.
 - Do not let the transmission hang from the clutch. Leave the jack under the transmission to support it.
2. Transmission to the clutch housing washers and bolts, as used.



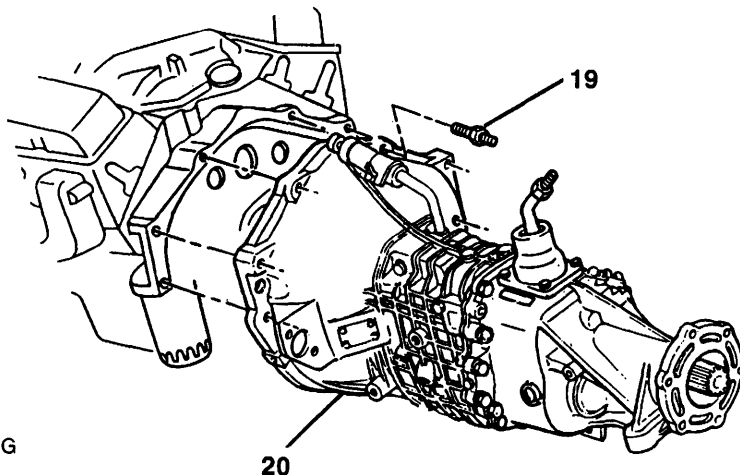
Tighten

- Bolts (19). Refer to "Specifications."
3. Crossmember.
 - Remove the jack.
 4. Bolts and the inspection cover (3500 transmission).



Tighten

- Bolts to 18 N.m (13 lbs. ft.).
5. Transmission vent hose (4500 transmission).
 6. Clutch slave cylinder. Refer to SECTION 7C.
 7. Electrical harnesses, as necessary.
 8. Exhaust pipes, if necessary. Refer to SECTION 6F.
 9. Parking brake and controls, if used. Refer to SECTION 5F.
 10. Transfer case, if used. Refer to SECTION 7D.
 11. Propeller shaft. Refer to SECTION 4A.
 - Lower the vehicle.
 12. Shift control lever, as used. Refer to "Shift Control Lever Replacement."
 13. New transmission oil. Refer to "Drain and Fill."

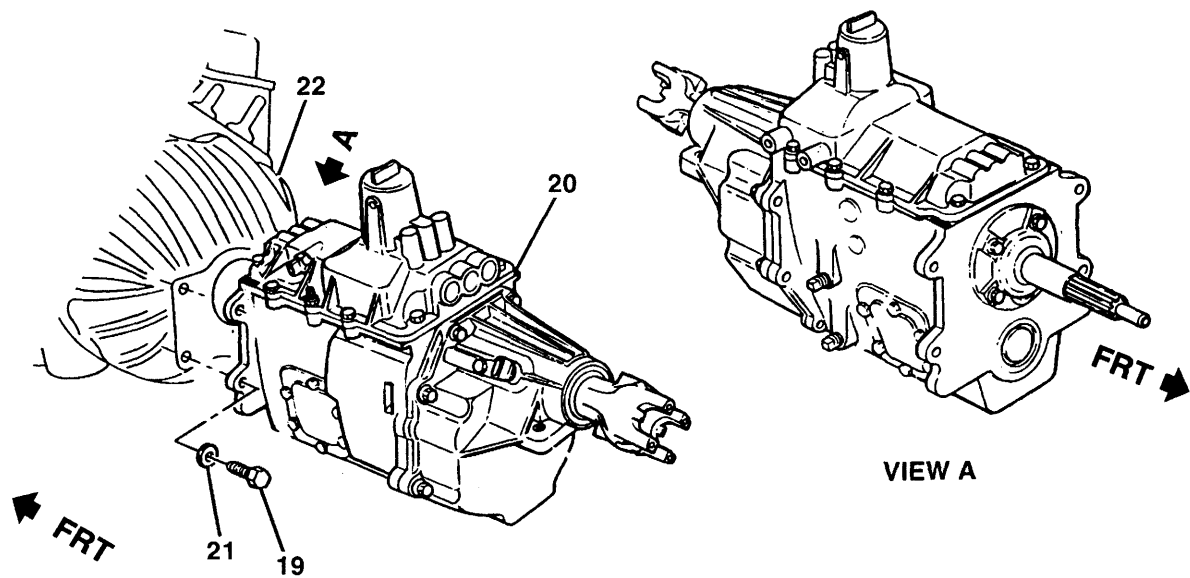


19. BOLT, TRANSMISSION MOUNTING
20. TRANSMISSION

V2710

Figure 10—Transmission Installation (New Venture Gear 3500) - 4WD Models

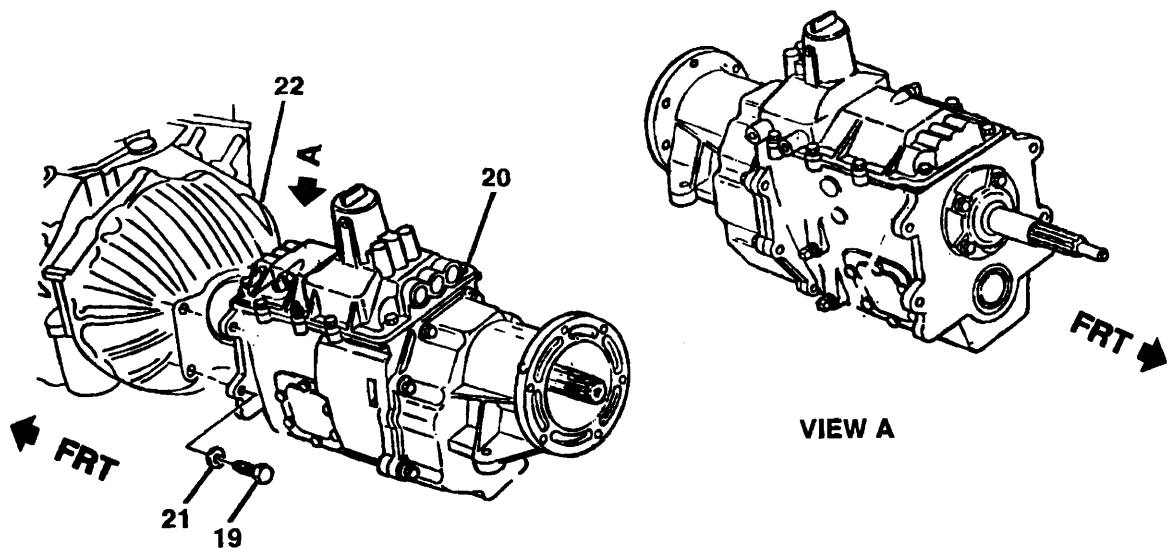
7B-8 MANUAL TRANSMISSION



- 19. BOLT, TRANSMISSION MOUNTING
- 20. TRANSMISSION
- 21. WASHER, TRANSMISSION MOUNTING
- 22. HOUSING, CLUTCH

V2711

Figure 11—Transmission Installation (New Venture Gear 4500) - 2WD Models



- 19. BOLT, 100 N·m (74 LBS. FT.)
- 20. TRANSMISSION
- 21. WASHER, TRANSMISSION MOUNTING
- 22. HOUSING, CLUTCH

3107r5273

Figure 12—Transmission Installation (New Venture Gear 4500) - 4WD Models

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Backup Lamp Switch	28 N·m (21 lbs. ft.)
Inspection Cover Mounting Bolts.....	18 N·m (13 lbs. ft.)
Oil Drain Plug (New Venture 3500).....	60 N·m (46 lbs. ft.)
Oil Fill Plug (New Venture 4500)	41 N·m (30 lbs. ft.)
Oil Fill Plug (New Venture 3500)	60 N·m (46 lbs. ft.)
PTO Cover Bolt (New Venture 4500).....	41 N·m (30 lbs. ft.)
Transmission to Clutch Housing Bolts (New Venture 4500).....	100 N·m (74 lbs. ft.)
Transmission to Engine Bolts (New Venture 3500).....	47 N·m (35 lbs. ft.)
Yoke Nut (New Venture 4500).....	441 N·m (325 lbs. ft.)

LUBRICATION SPECIFICATIONS

New Venture Gear 4500 Manual Transmission

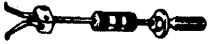
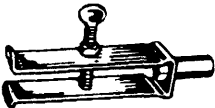
Capacity	3.78L (4.0 Qts.)
Type Recommended.....	Castrol Syntorq GL-4 Transmission Fluid

New Venture Gear 3500 Manual Transmission

Capacity	1.98L (2.0 Qts.)
Type Recommended.....	Synchromesh Transmission Fluid

T2850

SPECIAL TOOLS

- | | | | | | |
|----|---|---------|----|--|-----------|
| 1. |  | J 22834 | 4. |  | J 36502-A |
| 2. |  | J 23907 | 5. |  | J 36503 |
| 3. |  | J 26941 | 6. |  | J 36825 |

- 1. EXTENSION HOUSING SEAL INSTALLER
- 2. SLIDE HAMMER
- 3. OUTPUT SHAFT OIL SEAL REMOVER
- 4. EXTENSION HOUSING SEAL INSTALLER
- 5. EXTENSION HOUSING SEAL INSTALLER
- 6. OUTPUT SHAFT OIL SEAL REMOVER

SECTION 7C

CLUTCH

CAUTION: When servicing clutch parts, do not create dust by grinding or sanding clutch disc or by cleaning parts with a dry brush or compressed air. Many earlier models or aftermarket clutch parts may contain asbestos fiber which can become airborne if dust is created during servicing. A water dampened cloth or water based solution should be used to remove any dust on clutch parts. Equipment is commercially available to perform this washing function. These wet methods will prevent asbestos fibers from becoming airborne.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The principal parts of the clutch system are the driving members, the driven members, and the operating members.

DRIVING MEMBERS

The driving members consist of two flat surfaces machined to a smooth finish. One of these is the rear face of the engine flywheel, and the other is the front face of the clutch cover assembly.

DRIVEN MEMBERS

The driven member is the clutch disc with a splined hub which is free to slide lengthwise along the splines

of the input shaft, and drives the input shaft through these same splines.

The driving and driven members are held in contact by spring pressure. This pressure is exerted by a diaphragm spring in the clutch cover assembly.

OPERATING MEMBERS**HYDRAULIC CLUTCH**

The clutch release system consists of a clutch master cylinder with a reservoir and an actuator cylinder connected to the master cylinder by hydraulic tubing. The clutch master cylinder is mounted on the cowl panel

7C-2 CLUTCH

and the actuator is mounted on the clutch housing. The clutch master cylinder is operated directly off the clutch pedal by a pushrod.

When the clutch pedal is pressed down, hydraulic fluid under pressure from the clutch master cylinder flows into the actuator cylinder. As hydraulic force is applied to the actuator cylinder, the pushrod movement rotates the clutch fork to force the release bearing into the diaphragm spring and release the clutch.

The hydraulic clutch system provides automatic clutch adjustment, so no adjustment of clutch linkage or pedal position is required.

HYDRAULIC CLUTCH FLUID

When adding fluid to or refilling the system after service operations use GM Delco Supreme No. II® Brake Fluid or an equivalent fluid that meets DOT 3 specifications.

NOTICE: Do not use mineral or paraffin base oil in the clutch hydraulic system. These fluids will damage the rubber parts in the cylinders.

DIAGNOSIS

PRELIMINARY CHECKS

Before attempting to repair the clutch, transmission, or related components for any reason other than an obvious failure, identify the problem and probable cause. A large percentage of clutch and manual transmission problems are revealed by shifting difficulties such as high shift effort, gear clash, or grinding. When any of these problems occur, make a careful analysis of these difficulties. Use the "Diagnosis of Hydraulic Clutch" chart to assist in proper diagnosis of clutch problems.

Before removing the clutch hydraulic system, verify the malfunction by measuring the travel of the clutch actuator cylinder pushrod. When the clutch pedal is pushed fully to the floor stop, the actuator cylinder pushrod should move 25.4 mm (1.0 inch) minimum against the clutch release lever. Do not replace the hydraulic system if pushrod travel meets or exceeds this distance.

If the actuator cylinder does not meet the travel requirements, check the reservoir fluid level. The actuator cylinder must be in place when checking the fluid level. The proper level is 11 mm (0.43 in.) from the top lip of the reservoir. Fill to the specified level with GM

Delco Supreme No. II® Brake Fluid; Hydraulic Clutch Fluid or equivalent that meets DOT 3 specifications. Do not overfill the system.

NOTICE: Carefully clean the top and sides of the reservoir before opening to prevent contamination of the system with dirt, water, or other foreign material. Remove the reservoir diaphragm before adding fluid. Carefully replace the diaphragm and cover after filling.

If the reservoir requires any fluid, check the hydraulic system components for leakage. Remove the rubber boots from the cylinders and check for leakage past the pistons. A slight wetting of the surfaces is acceptable. Replace the system if excessive leakage is evident.

CLUTCH SPIN DOWN TIME

1. Run the engine at a normal idle with the transmission in neutral and the clutch engaged.
2. Disengage the clutch, wait 9 seconds, and shift the transmission into reverse.
3. If a grinding noise is heard, refer to the "Diagnosis Of Hydraulic Clutch" chart in this section.

DIAGNOSIS OF HYDRAULIC CLUTCH

PROBLEM	POSSIBLE CAUSE	CORRECTION
Pedal Travels To Floor. No Pressure Or Very Little Resistance.	Master or actuator cylinder faulty. Hose/pipe burst or leaking. No fluid in reservoir.	Replace assembly.
Pedal Travels To Floor. No Pressure Or Very Little Resistance. Fluid In Master Cylinder Dust Cover.	Rear seal failure in master cylinder.	Replace assembly.
Pedal Travels To Floor. No Pressure Or Very Little Resistance. Fluid Level In Reservoir Rises As Pedal Is Depressed.	Master cylinder center valve seal faulty	Replace assembly.

DIAGNOSIS OF HYDRAULIC CLUTCH (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Fluid In Area Of Master Cylinder Dust Cover And On Pedal	Rear seal failure in master cylinder.	Replace assembly.
Fluid In Actuator Cylinder And On Cylinder Body	Actuator cylinder plunger seal faulty.	Replace assembly.
Pedal Feels "Spongy" When Depressed	Air in system.	Check fluid level, bleed system, if necessary. Check and replace assembly if symptom recurs.
Unable To Select Gears. Pedal Effort And Travel Normal.	Clutch mechanism faulty. Transmission faulty.	Check and replace clutch or transmission components.
Clutch Slip	Clutch plate worn or contaminated.	Check and replace. Clean and service or replace assembly.
Difficulty In Selecting Gears. Pedal Effort And Travel Normal.	Clutch or transmission mechanism faulty.	Check and replace faulty or worn assembly.
Pedal Sticks or Binds During Travel.	Clutch fork ball stud worn. Release bearing or transmission bearing retainer worn. Clutch pedal bushings worn.	Check and replace worn parts.
D0255		

ON-VEHICLE SERVICE

CLUTCH PEDAL REPLACEMENT



Remove or Disconnect (Figure 1)

1. Negative battery cable. Refer to SECTION 0A.
2. Lower filler panel(s). Refer to SECTION 10A4.
3. Lower left side air conditioning duct, if needed. Refer to SECTION 1B.
4. Push rod from the clutch pedal.
5. Bolt, clutch pedal, and spring.
6. Bushings and spacer.



Install or Connect (Figure 1)

1. New spacer and bushings.
 - Coat with grease before installing.

NOTICE: Refer to "Notice" on page 7C-1.

2. Spring, clutch pedal, and bolt.



Tighten

- Clutch pedal bolt to 37 N.m (27 lbs. ft.).
3. Push rod to the clutch pedal.

4. Lower left side air conditioning duct, if needed. Refer to SECTION 1B.
5. Lower filler panel(s). Refer to SECTION 10A4.
6. Negative battery cable.

MASTER CYLINDER, HYDRAULIC LINE AND ACTUATOR CYLINDER ASSEMBLY REPLACEMENT



Remove or Disconnect (Figures 2 and 3)

1. Negative battery cable. Refer to SECTION 0A.
2. Lower filler panel(s), if needed. Refer to SECTION 10A4.
3. Lower left side air conditioning duct, if needed. Refer to SECTION 1B.
4. Push rod from the clutch pedal.
5. Master cylinder to cowl panel nuts.
6. Pull clip retaining clutch actuator hose from the bolt.

- If the assembly is being replaced it may be necessary to cut the line at the rear of engine to be able to remove assembly more easily.
- Raise the vehicle.

7. Actuator cylinder to clutch housing nuts.

7C-4 CLUTCH

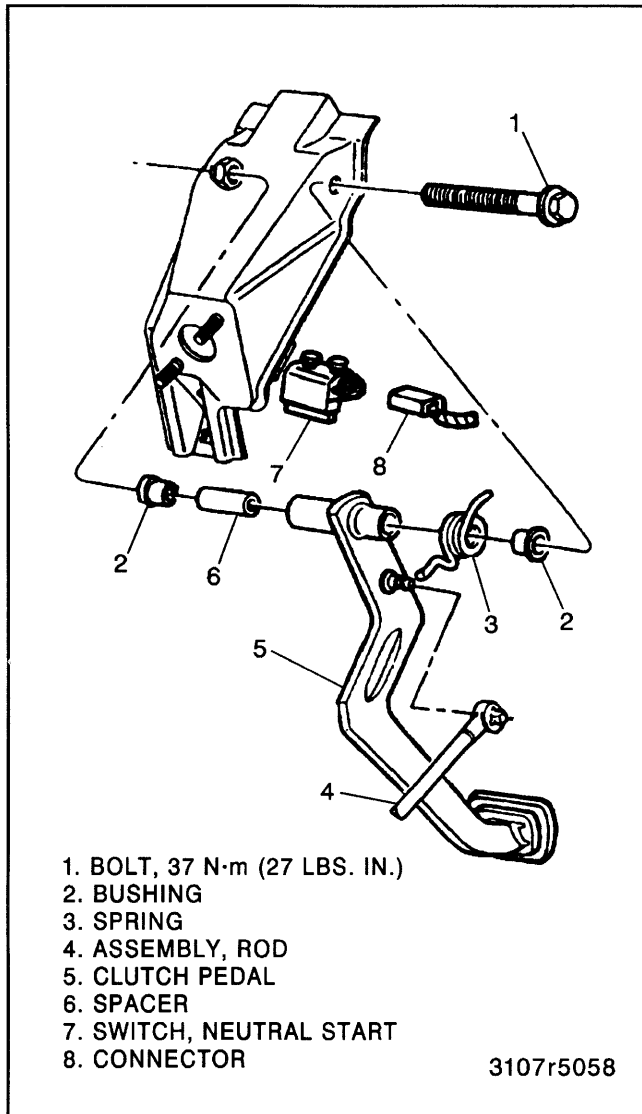


Figure 1—Clutch Pedal Assembly

8. Hydraulic line to engine nuts and clips (figure 3).
9. Hydraulic clutch assembly.
10. Inspection plug.
 - Lower the vehicle.

Install or Connect (Figures 2 and 3)

NOTICE: For steps 2, 5, and 7, refer to “Notice” on page 7C-1.

The system comes filled with fluid. Be sure the cap remains on during installation.

1. Install the assembly from the top.
 - Raise the vehicle.
 - The plastic retaining strap must be left on the actuator cylinder when it is installed. It will release upon the first pedal application.
2. Actuator cylinder to the clutch housing and nuts.

Tighten

- Actuator cylinder nuts to 18 N·m (13 lbs. ft.).
- Check push rod to assure the it is properly seated in the fork.

3. Inspection plug.

- Lower the vehicle.

4. Push rod assembly to the cowl.

5. Master cylinder to cowl panel and nuts.

Tighten

- Master cylinder nuts to 18 N·m (13 lbs. ft.).

6. Clip onto steering column bolt (figure 2).

- It may be necessary to secure clip with a nut.
- Raise the vehicle.

7. Clips and nuts retaining clutch actuator hose to the engine (figure 3).

Tighten

- Clip nuts to 4 N·m (35 lbs. in.).

- Lower the vehicle.

8. Push rod to the clutch pedal.

9. Lower left side air conditioning duct, if needed. Refer to SECTION 1B.

10. Lower filler panel(s). Refer to SECTION 10A4.

11. Negative battery cable.

- Check the fluid level in the reservoir and add as necessary, pump pedal several times the system should not need to be bled.
- If system needs to be bled. Refer to “Hydraulic Clutch Bleeding.”

HYDRAULIC CLUTCH BLEEDING

The hydraulic clutch system is prefilled with fluid. If fluid is inadvertently lost during component repair or replacement, the following bleed procedure can be used.

Bleed (Figures 2 and 3)

1. Disconnect the push rod from the clutch pedal.
2. Remove the actuator cylinder from the clutch housing.
3. Remove the reservoir cap.
4. Slowly depress the actuator cylinder push rod to the bottom of the bore.
5. While holding the actuator cylinder push rod, fill the reservoir with GM Delco Supreme No. II® Brake Fluid; Hydraulic Clutch Fluid or equivalent that meets DOT 3 specifications, if needed.
6. Slowly release the actuator cylinder push rod.
7. Hold actuator cylinder vertically with push rod facing the ground.
8. Depress the push rod into the actuator cylinder with short strokes of 5 mm - 10 mm (0.20 inch - 0.40 inch).

- Hold the push rod against palm of your hand in a position which allows the actuator cylinder to be lower than the master cylinder.
- Watch the reservoir for air bubbles.
- Stroke the actuator until the air bubbles are no longer entering the master cylinder.

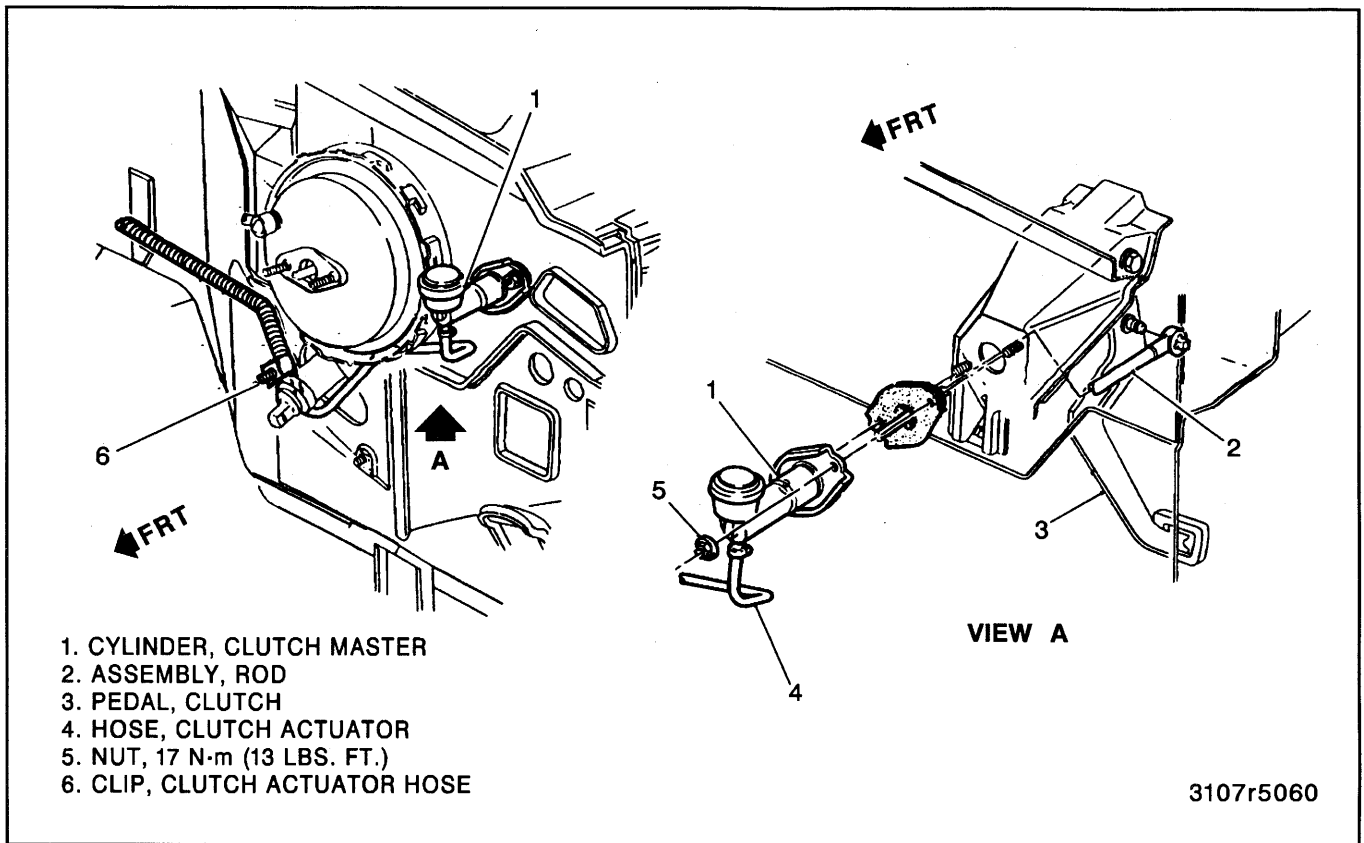


Figure 2—Master Cylinder and Reservoir

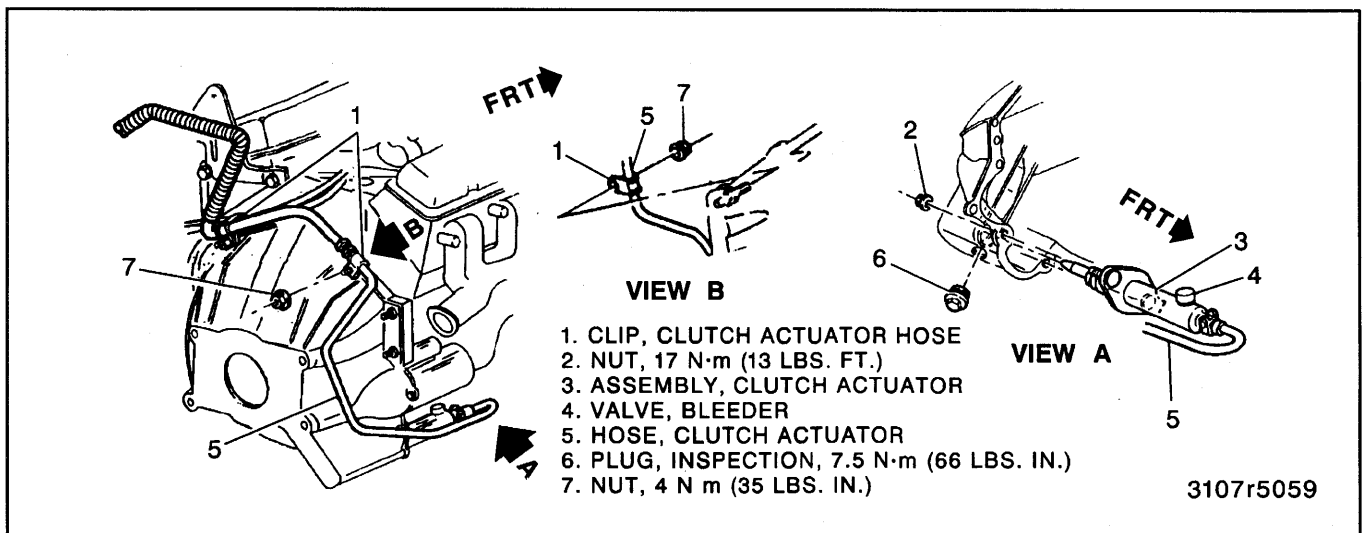


Figure 3—Actuator Cylinder and Hydraulic Hose

9. Install actuator cylinder to clutch housing.

- Align push rod into fork pocket.

- Fill reservoir with GM Delco Supreme No. II® Brake Fluid; Hydraulic Clutch Fluid or equivalent that meets DOT 3 specifications, if needed.
- Clean reservoir cap and install on reservoir.
- Connect push rod to the clutch pedal.

CLUTCH ASSEMBLY AND PILOT BEARING REPLACEMENT



Remove or Disconnect (Figures 4 and 5)

Tools Required:

- J 5824-01 Clutch Alignment Tool
- J 23907 Pilot Bearing Puller
- J 38149 Universal Puller

- Transmission (New Venture Gear 3500 and 4500). Refer to SECTION 7B.

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- Steps 2 through 6 for New Venture Gear 4500 transmission.
- 2. Actuator cylinder (figure 3).
 - Hydraulic line and clips.
- 3. Inspection cover to clutch housing bolts.
- 4. Inspection cover from the clutch housing.
- 5. Clutch housing to the engine studs.
- 6. Clutch housing from the engine.
- 7. Spring, seat, and clutch fork.
- 8. Clutch fork inspection plug.



Important

- Install J 5824-01 or a used clutch drive gear to support the clutch.
 - Mark the flywheel, clutch cover, and a pressure plate lug for alignment during installation.
9. Bolts and spring washers from clutch cover.



Important

- Loosen each bolt one turn at a time to avoid warping the clutch cover.
10. Cover assembly and driven plate.
 - Remove the clutch alignment tool.
11. Pilot bearing if it is worn or damaged. Use J 23907 or J 38149 as needed (figure 6).



Clean

1. All parts with a clean, water dampened cloth to remove any fibers.
2. Clutch fork, clutch housing, and ball stud with solvent. Wipe dry.

NOTICE: The release bearing is permanently packed with lubricant and should not be soaked in cleaning solvent since this will dissolve the lubricant.



Inspect

- All parts for wear and damage.
- Contact surfaces for scoring, and flatness with a straight edge.
- Friction pads for scoring, gouges, and loose rivets. Check to see if they are oil soaked.
- All splines for nicks, burrs, and sliding fit.
- All springs for bending and breaks.
- Boot for tears and brittleness.



Measure

- Transmission pilot hole in the clutch housing for runout using a dial indicator. Runout should not be more than 0.380 mm (0.015 inch).



Install or Connect (Figures 4 and 5)

Tool Required:

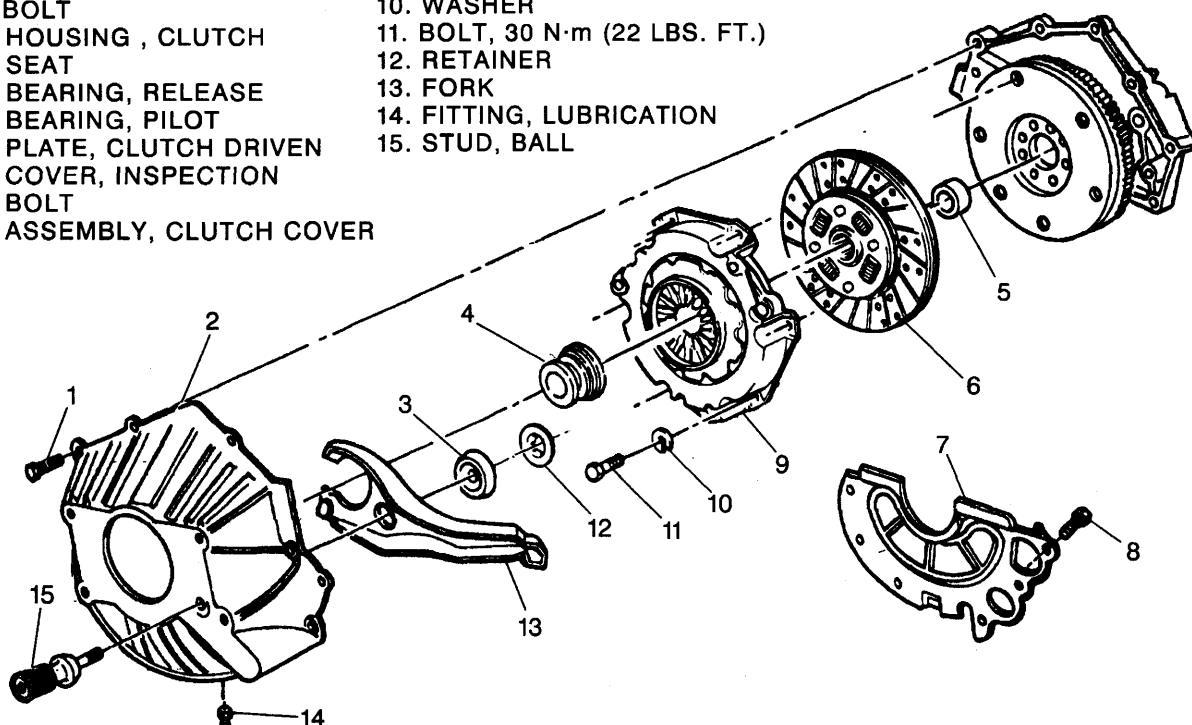
J 5824-01 Clutch Alignment Tool

Brass Drift or Equivalent (Gas Engines Only)

J 34140 Pilot Bearing Driver (6.5L Diesel Only)

NOTICE: For steps 3 and 7, refer to "Notice" on page 7C-1.

- | | |
|---------------------------|--------------------------------|
| 1. BOLT | 10. WASHER |
| 2. HOUSING, CLUTCH | 11. BOLT, 30 N·m (22 LBS. FT.) |
| 3. SEAT | 12. RETAINER |
| 4. BEARING, RELEASE | 13. FORK |
| 5. BEARING, PILOT | 14. FITTING, LUBRICATION |
| 6. PLATE, CLUTCH DRIVEN | 15. STUD, BALL |
| 7. COVER, INSPECTION | |
| 8. BOLT | |
| 9. ASSEMBLY, CLUTCH COVER | |



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Figure 4—Clutch Assembly and Pilot Bearing

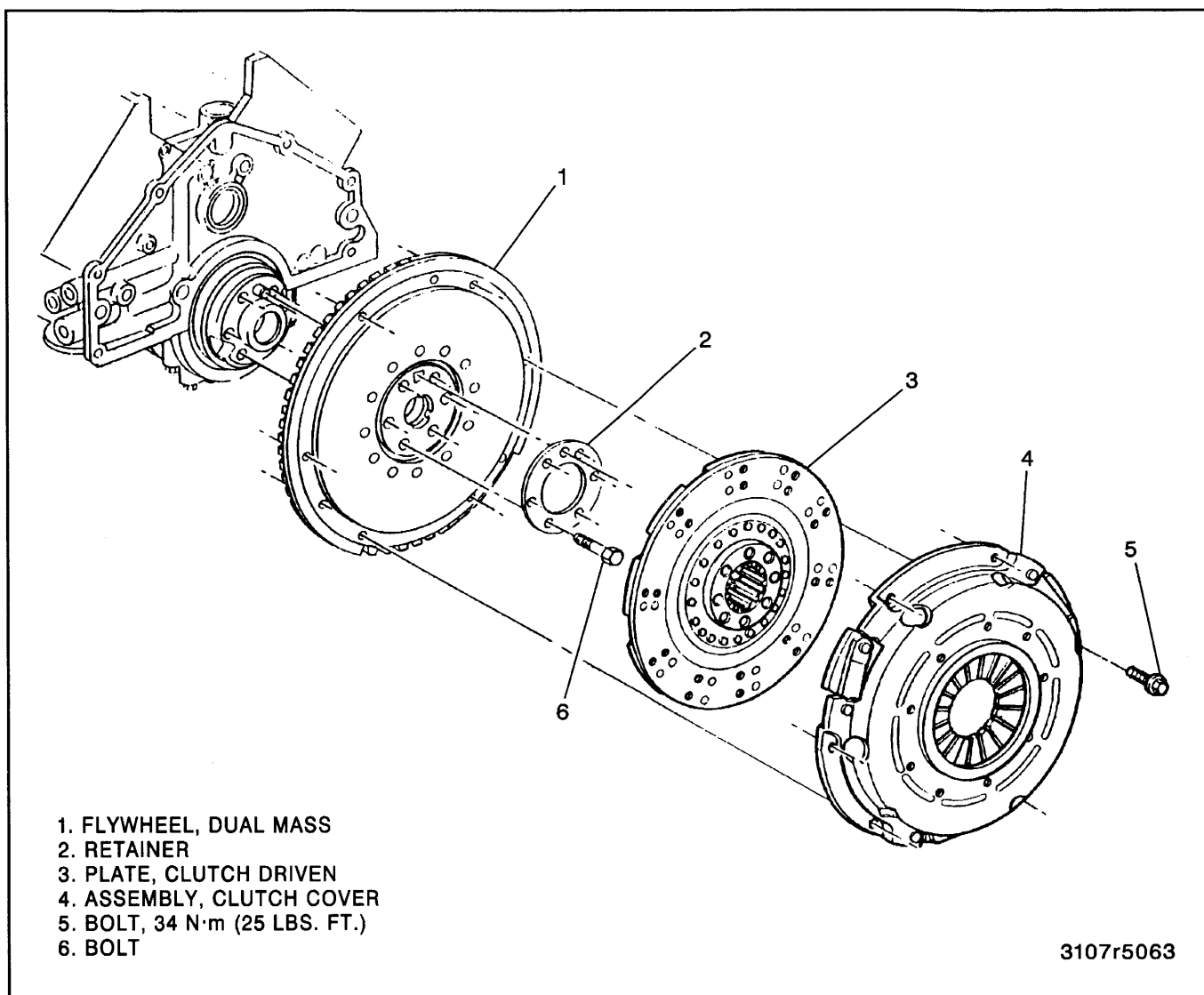


Figure 5—Clutch Assembly (Dual Mass Flywheel)

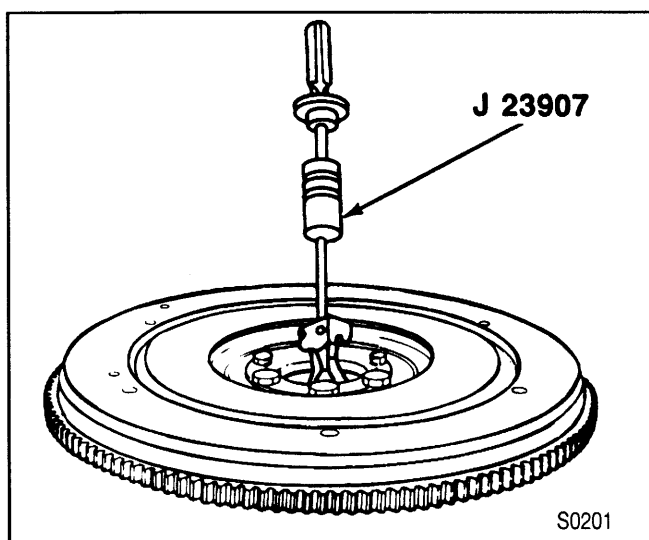


Figure 6—Pilot Bearing Removal

1. New pilot bearing if needed. Use Brass Drift or J 34140 as needed to drive the bearing in until the tool bottoms out.

— Gas Engine

- Lubricate the bearing with a few drops of machine oil.

— 6.5L Diesel Engine

- The bearing is sealed and does not need any lubrication.

2. Driven plate and cover assembly.



Important

- Install J 5824-01 or a used clutch drive gear to support the clutch.
- Align the marks made during removal or, if new, align the lightest part of the clutch cover, identified by a yellow dot, to the heaviest part of the flywheel, identified by an "X".

7C-8 CLUTCH

3. New spring washers and bolts.



Important

- Tighten each bolt one turn at a time to avoid warping the clutch cover.



Tighten

- Clutch cover bolts to 47 N·m (35 lbs. ft.).
- Clutch cover bolts (dual mass flywheel only) to 34 N·m (25 lbs. ft.).
- Remove the clutch alignment tool.

NOTICE: Be careful not to use too much lubricant. Excessive lubricant may get on the clutch disc and cause slippage, or damage may result to the clutch.

4. Ball stud.

- Coat the rounded end of the ball stud with high temperature grease.
- Pack the ball stud from the lubrication fitting on the clutch housing.

5. Release bearing and clutch fork.

- Pack the inside recess (A) and outside groove (B) of the release bearing with high temperature grease as shown (figure 7).
- Release bearing to the clutch fork.



Important

- Bearing retainer spring should be depressed and rest within groove (B) of the release bearing (figure 7).

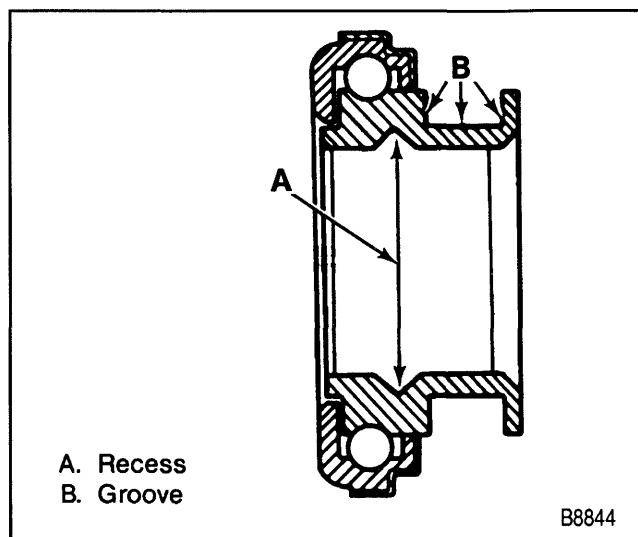


Figure 7—Release Bearing

6. Seat and retainer.

- Steps 7 through 10 for New Venture Gear 4500 transmission.

7. Clutch housing and studs.



Tighten

- Clutch housing studs to 39 N·m (29 lbs. ft.).

8. Inspection cover and bolts.

9. Actuator cylinder as needed (figure 3).

- Hydraulic line and clips.
- Make sure push rod is properly seated in the fork.

10. Clutch fork inspection plug.

11. Transmission. Refer to SECTION 7B.

FLYWHEEL REPLACEMENT

For flywheel replacement procedures, refer to SECTION 6.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

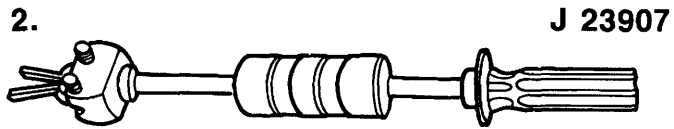
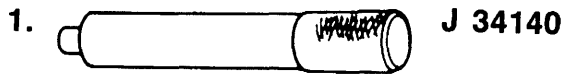
Actuator Cylinder-to-Clutch Housing Nut.....	18 N·m (13 lbs. ft.)
Clutch Housing Mounting Bolts	39 N·m (29 lbs. ft.)
Clutch Pedal Mounting Bolt.....	37 N·m (27 lbs. ft.)
Master Cylinder Mounting Nut.....	18 N·m (13 lbs. ft.)
Hydraulic Line-to-Clutch Housing Mounting Nut.....	4 N·m (35 lbs. in.)
Pressure Plate-to-Flywheel Mounting Bolts (All Except Dual Mass Flywheel)	47 N·m (35 lbs. ft.)
Pressure Plate-to-Flywheel Mounting Bolts (Dual Mass Flywheel Only).....	34 N·m (25 lbs. ft.)

LUBRICATION SPECIFICATIONS

Capacity	Fill to Level of Diaphragm
Type Recommended	DOT 3 Brake Fluid or Equivalent

T2849

SPECIAL TOOLS



- 1. Pilot Bearing Driver
- 2. Clutch Pilot Bearing Remover
- 3. Clutch Alignment Tool

F9766

NOTES

SECTION 7D

TRANSFER CASE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The transfer case is used to provide power flow from the transmission to the front axle. The transfer case also provides a way of disconnecting the front axle to provide better fuel economy and quieter operation when the vehicle is driven on roads where four wheel drive is not required. The transfer case provides an additional gear reduction when placed in low range. This is useful when difficult off-road conditions are encountered.

The New Process Model 241 transfer case is used on all four wheel drive vehicles under 9200 lbs. GVW. The K30 Models with single or dual rear wheels (RPO-R05)

will use the Borg-Warner Models 4401 or 4470 transfer case.

All three models are aluminum case, chain driven units with four modes of operation: neutral, two wheel drive high range, four wheel drive high range, and four wheel drive low range. Gear reduction for low range is provided by a planetary gear set.

A floor mounted shift lever is used to select the operating range. Indicator lamps on the floor console show the current mode of operation. When four wheel drive has been selected, the four wheel drive indicator lamp

7D-2 TRANSFER CASE

is designed to come on whenever the front axle has engaged. A slight delay for the front axle indicator lamp to come on is normal.

OPERATION

TWO-WHEEL DRIVE OPERATION

When the transfer case is in "2 WHEEL" range, torque flows from the input gear to the range shift hub and main shaft, through the propeller shaft, to the rear axle. A switch in the shifter mechanism causes the "2 WHEEL" indicator lamp to turn on.

FOUR-WHEEL DRIVE HIGH RANGE OPERATION

Shifting into the "4 HI" range causes the following to happen:

1. A switch in the shifter mechanism causes the "2 WHEEL" indicator lamp to turn off and the "4 HI" indicator lamp to turn on. The front axle indicator lamp does not come on immediately.
2. Torque flows from the input gear to the mainshaft the same as in the "2 WHEEL" position. The shift linkage moves the mode synchronizer sleeve into engagement with the clutch teeth of the drive sprocket. This locks the drive sprocket to the mainshaft through the synchronizer sleeve.
3. Torque is transmitted through the drive sprocket and drive chain to the driven sprocket and output shaft. Torque then flows through the front propeller shaft to the front axle.
4. The shift mechanism in the transfer case closes a switch. Current is then applied to the front axle thermal actuator.
5. The thermal actuator contains a heating element, a gas charge, and a piston. When current is applied, the heating element heats the gas. The gas expands, pushing the piston out after a delay of a few seconds. The piston actuates the shift fork in the front axle. This connects the right axle output shaft to the front axle differential. Torque is then available at the front wheels.
6. The front axle shift mechanism, when fully engaged, closes a switch, causing the front axle indicator lamp to come on. For more information on the front axle shift mechanism and actuator, refer SECTION 4C.

7. If the shift lever is moved back to the "2 WHEEL" position, the operations in the preceding steps is reversed. The current to the thermal actuator is turned off. The gas cools, and the piston retracts, allowing the shift fork in the front axle to return to the two-wheel drive position.

FOUR-WHEEL DRIVE LOW RANGE OPERATION

1. When the transfer case is shifted into the "4 LO" position, torque flow and operation is similar to the "4 HI" range, except that the range shift hub engages the planetary carrier. The planetary gear set then provides a gear reduction to the front and rear axles.
2. A switch in the shifter mechanism causes the "4 HI" indicator lamp to turn off and the "4 LO" indicator lamp to turn on.

ELECTRONIC SYNCHRONIZER OPERATION (MODELS 4401 and 4470 ONLY)

The electronic synchronizer is used in model 4401 and 4470 transfer cases to provide smoother shifting. The system requires no maintenance or service.

The system consists of a relay and a clutch coil (electromagnet) inside the transfer case. The clutch coil replaces the conventional blocker ring. When energized, the clutch coil provides synchronization, resulting in a smooth shift. When the transfer case lever is moved to "4 HI" or "4 LO" position, current is supplied to the normally closed relay (figure 1). Current flows through the relay to the clutch coil. When the front axle engages, the axle switch energizes the relay coil. The relay switch then opens, and current to the clutch coil is interrupted.

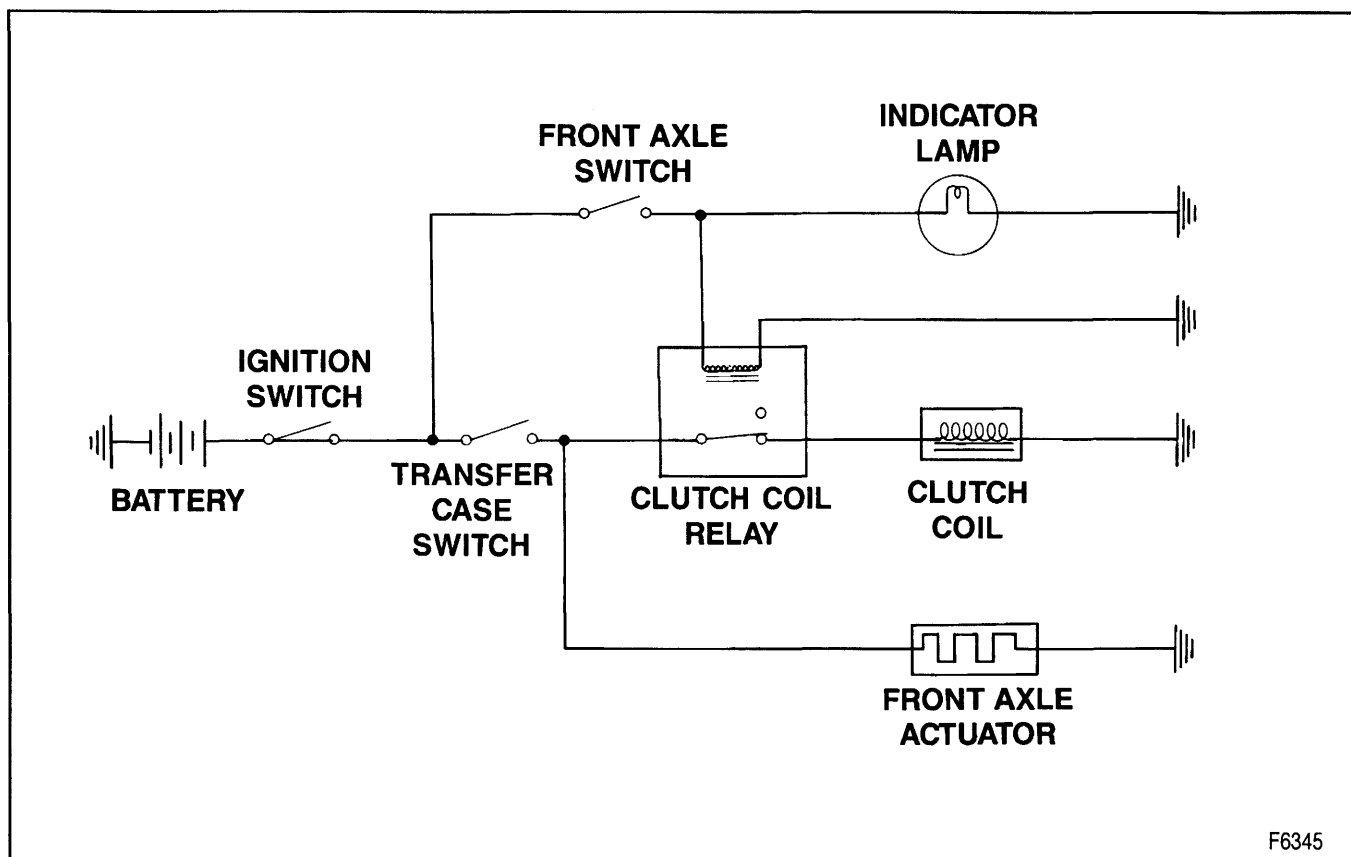
IDENTIFICATION

NEW PROCESS MODEL 241

An identification tag is attached to the rear case half. The tag provides the transfer case model number, low range reduction ratio, and assembly part number.

BORG-WARNER MODELS 4401 and 4470

An identification tag is attached to an extension housing bolt. The tag provides the transfer case model number, serial number, build date, and low range reduction ratio.



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Figure 1—Four Wheel Drive System Wiring Schematic

DIAGNOSIS OF TRANSFER CASE

PROBLEM	POSSIBLE CAUSE	CORRECTION
Four Wheel Drive Does Not Engage	1. Blown A/C-HTR fuse. 2. Faulty transfer case switch. 3. Transfer case linkage improperly adjusted or disconnected. 4. Faulty transfer case: Drive chain broken, range selector ring broken, etc. 5. Faulty front axle.	1. Replace. 2. Replace. 3. Adjust or repair. 4. Repair. Refer to the Light Duty Truck Unit Repair Manual. 5. Refer to SECTION 3C.
Four Wheel Drive Engages But Indicator Lamp Will Not Light	1. Blown bulb. 2. A/C-HTR fuse blown. 3. Faulty front axle switch. 4. Faulty wiring.	1. Replace. 2. Replace. 3. Replace. 4. Repair open in wiring.
Four Wheel Drive Indicator Lamp Will Not Turn Off (4WD Disengages Properly)	Faulty front axle switch.	Replace.
Four Wheel Drive Will Not Disengage	1. Transfer case linkage binding or improperly adjusted. 2. Faulty front axle shift mechanism.	1. Repair or replace. 2. Refer to Section 3C.

DIAGNOSIS OF TRANSFER CASE (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Jumps Out of Four Wheel Drive	1. Transfer case linkage binding or improperly adjusted. 2. Worn or damaged engine or transmission mountings. 3. Transfer case mounting bolts loose. 4. Drive shaft slip splines dry or loose. 5. Transfer case or front axle internal problem.	1. Adjust or repair. 2. Replace. 3. Tighten. 4. Lubricate or replace. 5. Refer to the Light Duty Truck Unit Repair Manual.
Transfer Case Shift Lever Difficult To Shift or Will Not Shift into 4 LOW or NEUTRAL (Vehicle Moving)	Vehicle in motion when attempting to shift. Stop the vehicle when shifting into or out of 4 LOW or NEUTRAL.	None required.
Transfer Case Difficult to Shift	1. In extremely cold weather, it may be necessary to reduce vehicle speed or stop before shifting from 2 WHEEL to 4 HIGH. 2. If the vehicle has been operated for an extended period in 4 HIGH mode on dry pavement, difficult shifting may result due to driveline torque lock. Stop the vehicle, shift transmission to neutral and shift transfer case into desired mode. 3. Transfer case linkage binding. 4. Low transfer case lubricant level, or improper lubricant used. 5. Internal transfer case problem. 6. Faulty wiring or electronic synchronizer (Models 4401 and 4470).	1. None required. 2. Operate the vehicle in 2 WHEEL mode on dry pavement. Oversize under-inflated tires may also cause torque lock. 3. Adjust or repair. 4. Fill with proper lubricant. 5. Repair. 6. Test as outlined later and repair as needed.
Transfer Case Noisy in All Modes	1. Low lube level or improper lubricant used. 2. Worn, under-inflated, or oversize tires. 3. Internal transfer case problem.	1. Fill with proper lubricant. 2. Replace or inflate. 3. Refer to the Light Duty Truck Unit Repair Manual.
Noisy In Or Jumps Out Of 4 LOW Range	1. Transfer case not completely engaged in 4 LOW range. Stop vehicle, shift into NEUTRAL, then back to 4 LOW. 2. Shift linkage loose or binding. 3. Transfer case internal shift mechanism faulty.	1. None required. 2. Repair. 3. Refer to the Light Duty Truck Unit Repair Manual.
Lubricant Leaking From Transfer Case Vent	1. Transfer case overfilled.	1. Drain lubricant to proper level.
Lubricant Leak At Output Shaft Seals	1. Transfer case overfilled. 2. Vent hose plugged or kinked. 3. Output shaft seals damaged or incorrectly installed.	1. Drain lubricant to proper level. 2. Repair. 3. Replace.
Abnormal Front Tire Wear	1. Front end needs alignment. 2. Extended operation on hard, dry surfaces in 4 HIGH mode.	1. Align to specifications. Refer to Section 3A. 2. Operate vehicle in 2 WHEEL mode on hard, dry surfaces.

ELECTRONIC SYNCHRONIZER SYSTEM CHECK (MODELS 4401 AND 4470 ONLY)

1. Place the ignition switch in the RUN position with 4WD engaged. It may be necessary to rotate the front tires slightly for the front axle to fully engage.
2. Disconnect the electronic synchronizer connector at the transfer case. Connect a test lamp from the wiring harness connector to a ground. The test lamp should light.

3. If the test lamp does not light, check the circuit for opens. If none are found, replace the relay as outlined later.
4. If the test lamp lights in step 2, check the synchronizer coil for continuity. If the coil is open, replace it as outlined in the Light Duty Truck Unit Repair Manual. If the synchronizer coil has continuity, it is probably OK. Recheck fluid levels, linkage adjustments, etc. before presuming the synchronizer to be faulty.

ON-VEHICLE SERVICE

TRANSFER CASE OIL CHANGE



Remove or Disconnect

- Raise the vehicle and support with safety stands.
- Place a drain pan under the drain plug.

1. Drain plug. Allow the oil to drain.
2. Fill plug.



Install or Connect

NOTICE: Refer to "Notice" on page 7D-1.

1. Drain plug.



Tighten

- Drain plug to 25 N·m (18 lbs. ft.).

2. Oil as described in SECTION 0B. Fill the transfer case until the oil level is at the bottom of the filler plug hole.
3. Fill plug.



Tighten

- Fill plug to 25 N·m (18 lbs. ft.).
- Lower the vehicle.

TRANSFER CASE LINKAGE ADJUSTMENT

Refer to figure 2.

1. Place the shift lever in the "4 HI" position.
2. Raise the vehicle and support with safety stands.
3. Disconnect the linkage rod from the console shift lever.
4. Shift the transfer case into "4 HI" position (transfer case shift lever in full forward detent).
5. Adjust the swivel to align with the hole in the console shift lever.
6. Lower the vehicle.

SKID PLATE REPLACEMENT



Remove or Disconnect (Figure 3)

- Raise the vehicle and support with safety stands.
1. Skid plate to the frame nuts and bolts.
 2. Skid plate from the frame.



Install or Connect (Figure 3)

1. Skid plate to the frame.

NOTICE: Refer to "Notice" on page 7D-1.

2. Skid plate to the frame nuts and bolts.



Tighten

- Bolts to 63 N·m (46 lbs. ft.).
- Lower the vehicle.

SHIFT LEVER REPLACEMENT



Remove or Disconnect (Figures 2, 4, and 5)

1. Shift knobs from the transfer case and transmission shift levers.
2. Console to the floor screws.
3. Console.
4. Indicator lamp harness from the console.
5. Shift lever to the floor bolts.
- Raise the vehicle and support with safety stands.
6. Swivel from the shift lever.
7. Shift lever from vehicle.



Install or Connect (Figures 2, 4, and 5)

NOTICE: For steps 3 and 6, refer to "Notice" on page 7D-1.

1. Shift lever to the vehicle.
2. Swivel to the shift lever.
- Lower the vehicle.
3. Shift lever to the floor bolts.



Tighten

- Shift lever to the floor bolts to 11 N·m (97 lbs. in.).
4. Console.
 5. Indicator lamp harness to the console.
 6. Console to the floor screws.

7D-6 TRANSFER CASE

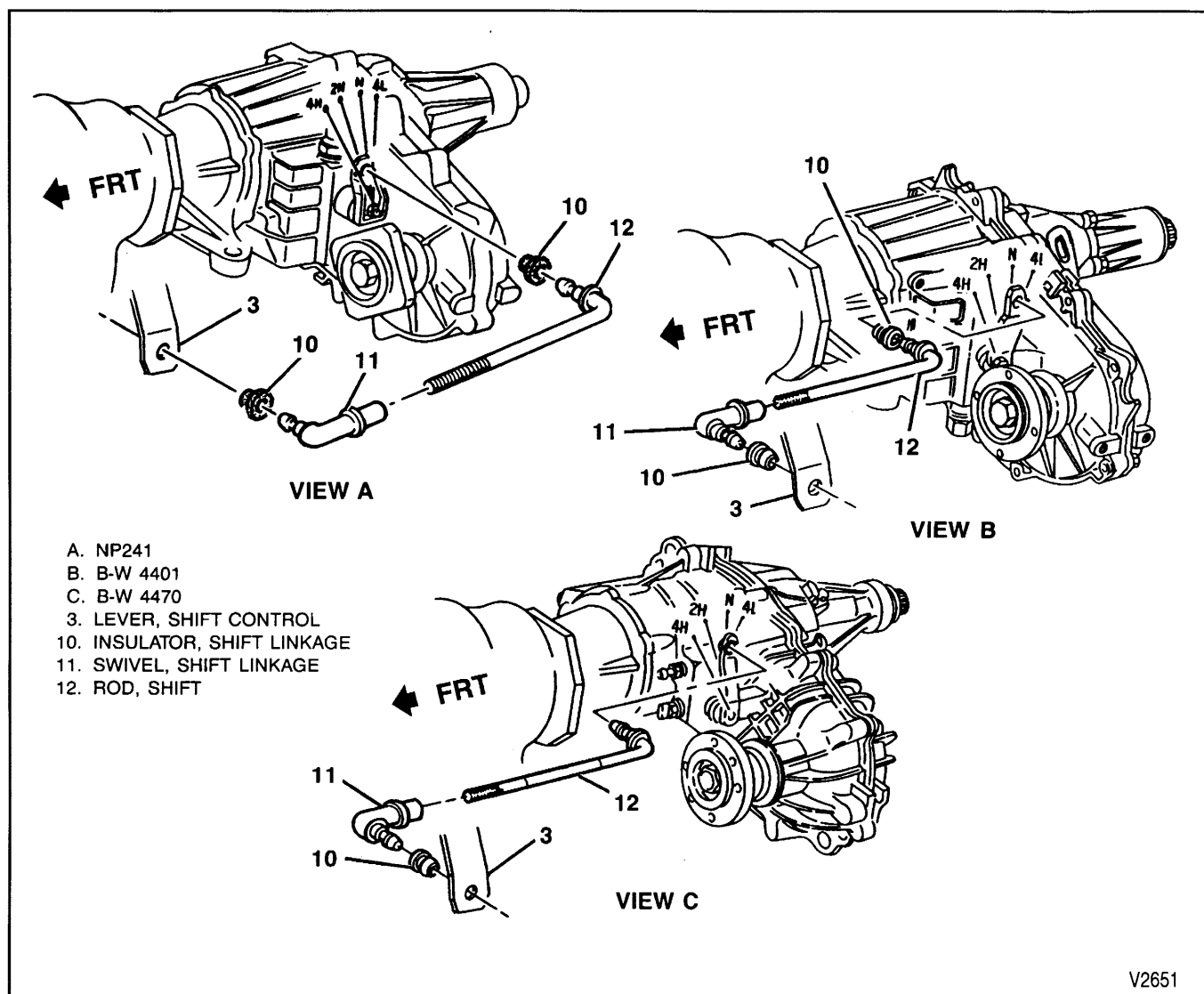


Figure 2—Transfer Case Linkage



Tighten

- Console to the floor screws to 1.4 N.m (12 lbs. in.).

7. Shift knobs to the shift levers.

CLUTCH COIL RELAY REPLACEMENT

The relay is mounted to the cowl, under the hood.



Remove or Disconnect (Figure 6)

1. Wiring harness retainer.
2. Wiring harness connector.
3. Relay screws.
4. Clutch coil relay.



Install or Connect (Figure 6)

1. Clutch coil relay.

NOTICE: Refer to "Notice" on page 7D-1.

2. Relay screws.



Tighten

- Relay screws to 2.8 N.m (25 lbs. in.).

3. Wiring harness connector.

4. Wiring harness retainer.

TRANSFER CASE SWITCH REPLACEMENT

The switch is located on the left upper side of the transfer case (figure 7).



Remove or Disconnect (Figure 7)

- Raise the vehicle and support with safety stands.
1. Wiring harness connector from the switch.
 2. Switch from the transfer case.



Install or Connect (Figure 7)

1. Switch to the transfer case. Coat the threads with thread sealant.
 2. Wiring harness connector.
- Lower the vehicle.

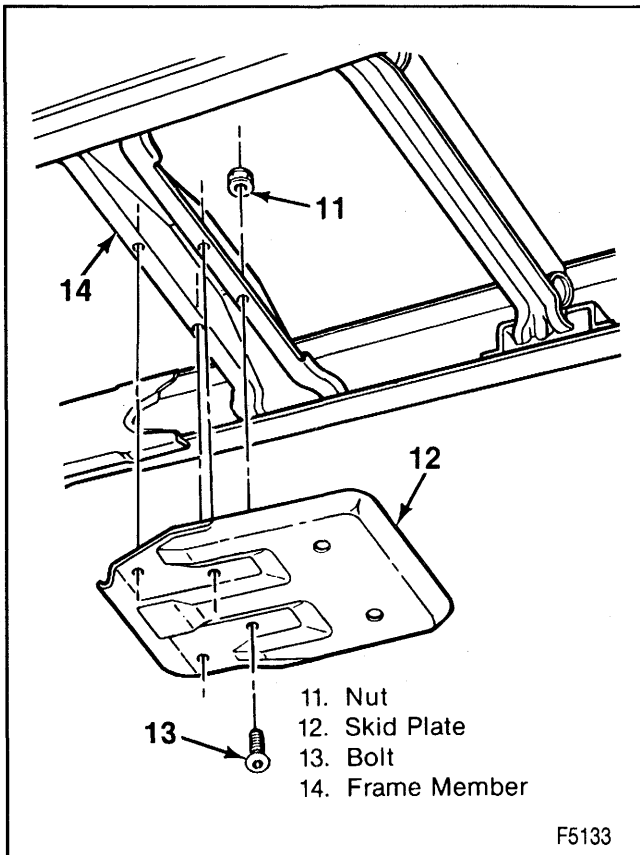


Figure 3—Skid Plate Replacement

VENT HOSE REPLACEMENT

When replacing the vent hose, be sure to route it as shown in figure 7. The installed hose must be free of kinks.

TRANSFER CASE OUTPUT SHAFT SEAL REPLACEMENT

This applies to front and rear output shaft seals.

Remove or Disconnect (Figures 8, 9, and 10)

- Raise the vehicle and support with safety stands.
- 1. Front or rear propeller shaft.
- 2. Propeller shaft yoke nut and flat washers (not used at rear on some models).
- 3. Propeller shaft yoke or flange.
- 4. Shield (if used).
- 5. Seal. Pry out with a screwdriver. Use care not to damage the sealing bore.

Install or Connect (Figures 8, 9, and 10)

Tools Required:

J 29162 Rear Output Shaft Seal Installer (NP 241 Transfer Case)

J 37668-A Output Shaft Seal Installer (B-W 4401 and 4470 Transfer Cases)

1. Seal.
 - A. Lubricate the seal lips with ATF or petroleum jelly.
 - B. Install the seal using the proper tool (figure 10).

C. NP 241 transfer case (all vehicles except K30 with dual rear wheels): Use J 29162 for front seal and rear seal.

D. B-W 4401 and 4470 transfer cases (K30 with dual rear wheels): Use J 37668-A.

2. Shield (if used).
3. Propeller shaft yoke or flange.

NOTICE: Refer to "Notice" on page 7D-1.

4. Flat washers and nut (if used).



Tighten

- Nut to specifications.
- NP 241 transfer case: 149 N.m (110 lbs. ft.).
- B-W 4401 and 4470 transfer case (front nut): 225 N.m (165 lbs. ft.).
- B-W 4401 and 4470 transfer case (rear nut): 170 N.m (125 lbs. ft.).

5. Propeller shaft.

- Check the transfer case lubricant level and add as necessary.
- Lower the vehicle.

REAR EXTENSION AND PUMP RETAINER HOUSINGS REPLACEMENT (NP 241 TRANSFER CASE)



Remove or Disconnect (Figure 8)

- Raise the vehicle and support with safety stands.
- 1. Rear propeller shaft and yoke.
- 2. Rear extension housing bolts.
- 3. Snap ring.
- 4. Pump retainer housing bolts.
- 5. Pump retainer housing.
- 6. Seal. Pry out with a screwdriver. Use care not to damage the sealing bore.



Clean

- Gasket surfaces with a suitable solvent.



Install or Connect (Figure 8)

NOTICE: For steps 2 and 5, refer to "Notice" on page 7D-1.

Tool Required:

J 29162 Rear Output Shaft Seal Installer

1. Pump retainer housing.
 - A. Make sure the gasket surfaces are clean and free of grease and oil.
 - B. Apply RTV sealer to the pump retainer housing sealing surfaces.
2. Pump retainer housing bolts.
 - Apply Loctite 242 (GM P/N 9985283) or equivalent to the threads of the bolts.

7D-8 TRANSFER CASE

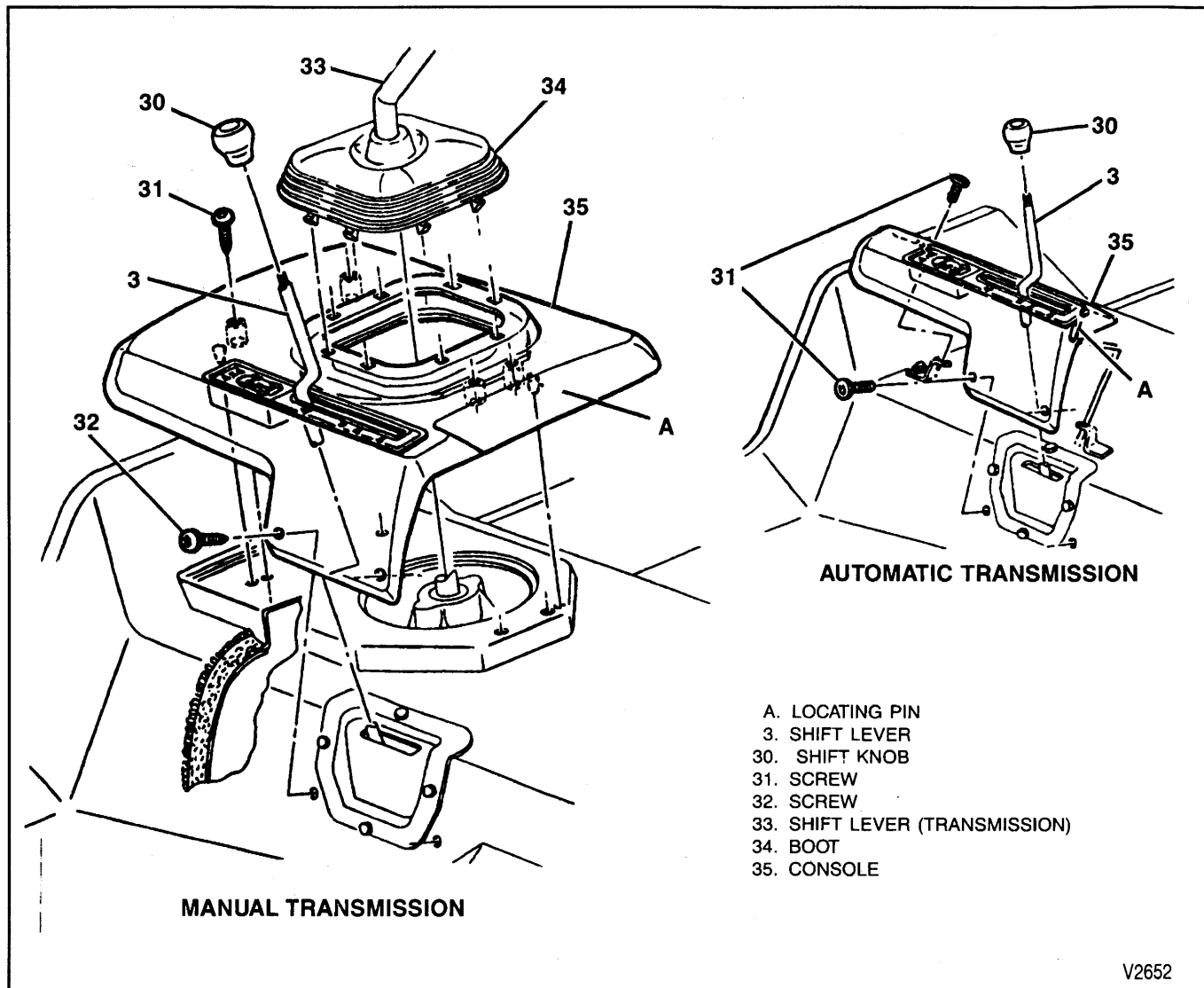


Figure 4—Console Installation



Tighten

- Bolts to 40 N.m (30 lbs. ft.).
- 3. Snap ring.
- 4. Rear extension housing to the transfer case.
 - A. Make sure the gasket surfaces are clean and free of grease and oil.
 - B. Apply RTV sealer to the rear extension housing sealing surfaces.
- 5. Rear extension housing bolts.
 - Apply Loctite 242 (GM P/N 9985283) or equivalent to the threads of the bolts.



Tighten

- Bolts to 31 N.m (23 lbs. ft.).
- 6. Seal.
 - A. Lubricate the seal lips with ATF or petroleum jelly.
 - B. Install using J 29162 (figure 10).
- 7. Rear propeller shaft and yoke.
 - Fill the transfer case with the proper lubricant. Refer to SECTION 0B.
 - Lower the vehicle.

TRANSFER CASE REPLACEMENT



Remove or Disconnect (Figure 11)

1. Negative battery cable. Refer to SECTION 0A.
 - Raise the vehicle and support with safety stands.
2. Skid plate (if equipped). Refer to "Skid Plate Replacement."
- Drain the oil from the transfer case.
3. Front propeller shaft. Refer to SECTION 4A.
4. Rear propeller shaft. Refer to SECTION 4A.
5. Electrical connections at the transfer case.
6. Transfer case shift linkage at the transfer case.
 - Support the transfer case with a jack.
7. Transfer case to the transmission bolts and spring washers (if used).
8. Gasket.



Install or Connect (Figure 11)

1. New gasket to the transmission. Use gasket sealer to hold it in place.

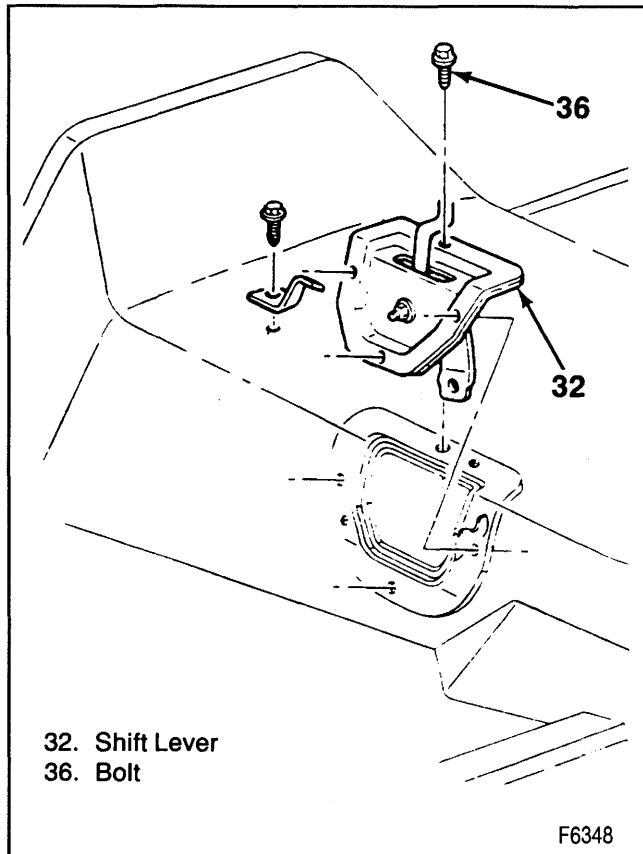


Figure 5—Shift Lever Installation

2. Transfer case to the vehicle.

NOTICE: Refer to "Notice" on page 7D-1.

3. Transfer case to the transmission bolts and spring washers (if used).



Tighten

- Bolts to 45 N.m (33 lbs. ft.).
 - Remove the jack from the transfer case.
4. Transfer case shift linkage at the transfer case.
 5. Electrical connections to the transfer case.
 6. Rear propeller shaft. Refer to SECTION 4A.
 7. Front propeller shaft. Refer to SECTION 4A.
 8. Skid plate (if equipped). Refer to "Skid Plate Replacement."
 - Fill the transfer case with the proper lubricant. Refer to SECTION 0B.
 - Lower the vehicle.
 9. Negative battery cable.

TRANSFER CASE ADAPTER REPLACEMENT (AUTOMATIC TRANSMISSIONS)



Remove or Disconnect (Figure 11)

1. Transfer case. Refer to "Transfer Case Replacement."
2. Transmission mount to the adapter bolts.

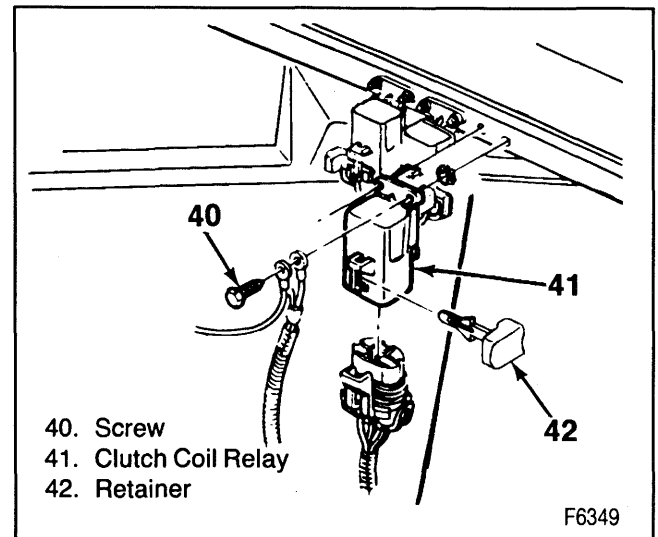


Figure 6—Clutch Coil Relay

- Raise the rear of the transmission slightly.

3. Adapter to the transmission bolts.
4. Adapter from the transmission.
5. Seal.



Install or Connect (Figure 11)

NOTICE: For steps 3 and 4, refer to "Notice" on page 7D-1.

1. Seal.
2. Adapter to the transmission.
3. Adapter to the transmission bolts.



Tighten

- Adapter bolts to 45 N.m (33 lbs. ft.).
 - Lower the rear of the transmission.
4. Transmission mount to the adapter bolts.



Tighten

- Bolts to 47 N.m (35 lbs. ft.).
5. Transfer case. Refer to "Transfer Case Replacement."

7D-10 TRANSFER CASE

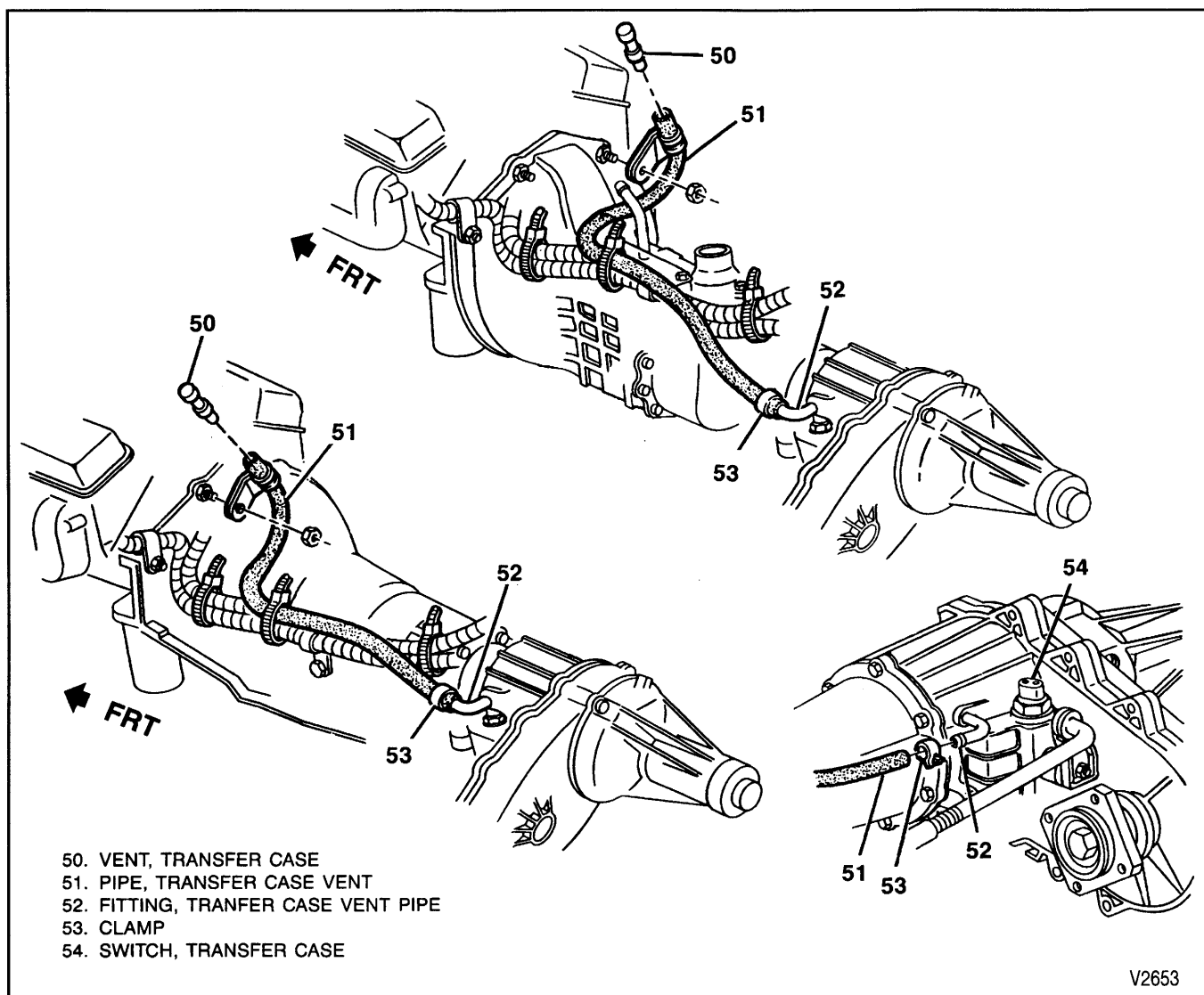


Figure 7—Vent Hose Routing

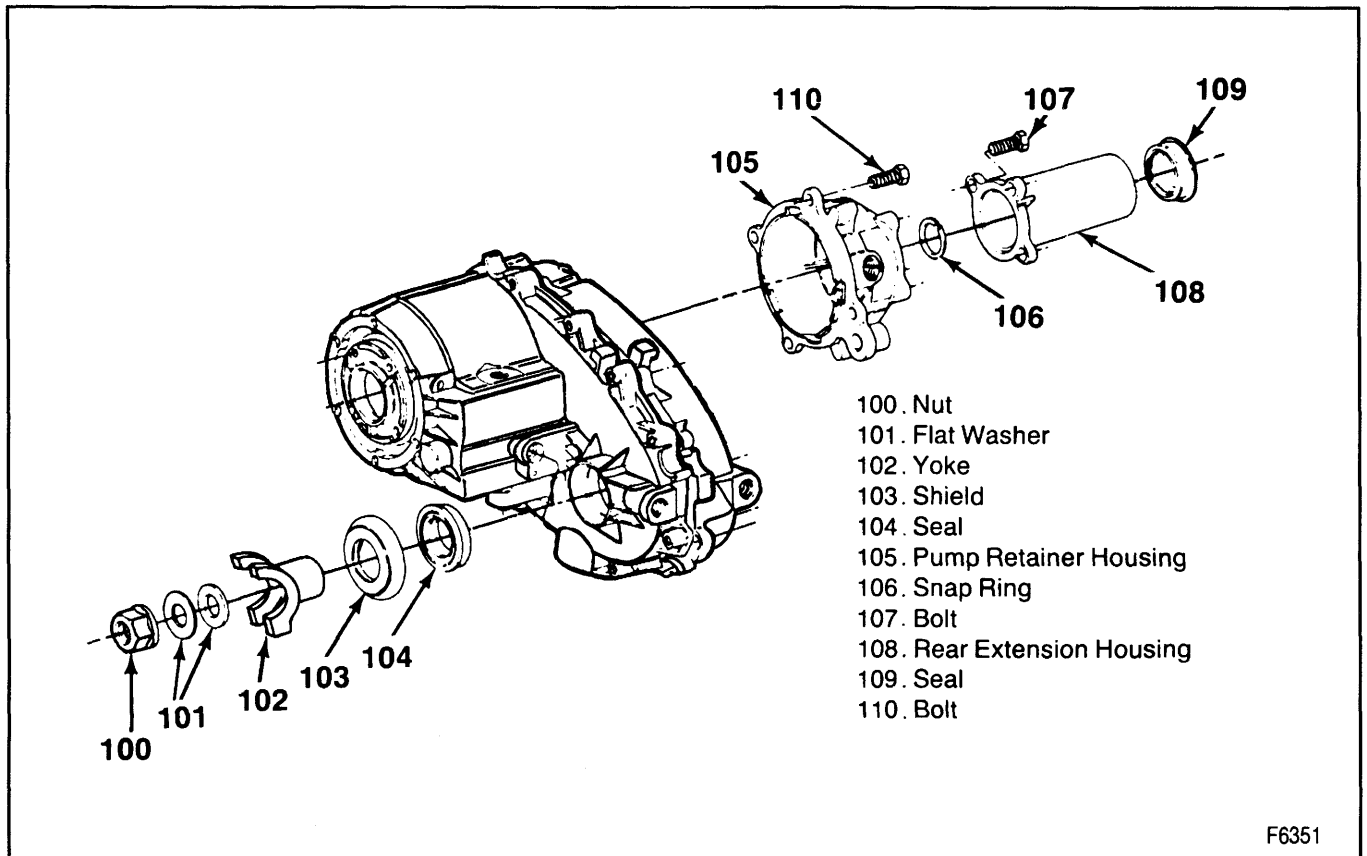


Figure 8—NP 241 Transfer Case Components

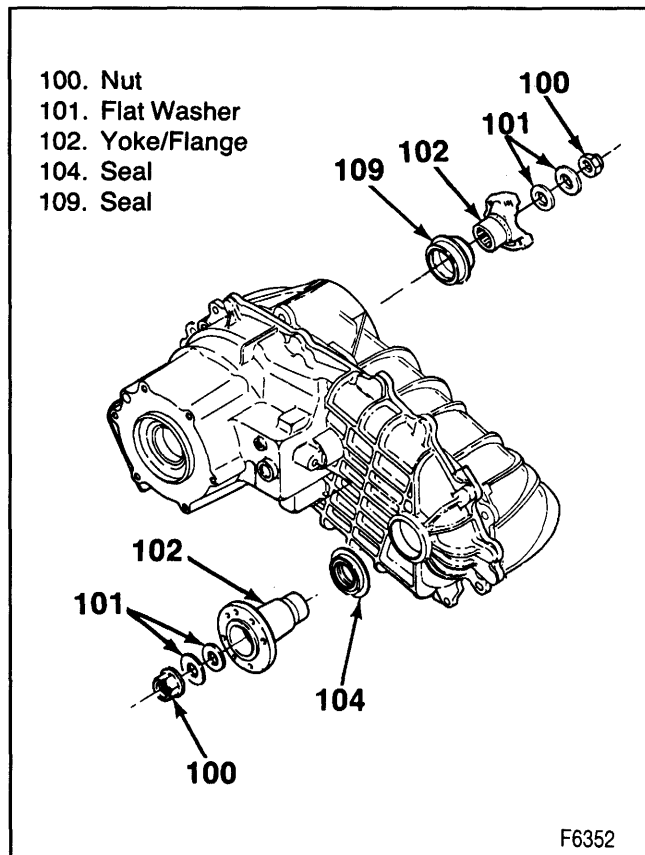


Figure 9—BW 4401 and 4470 Transfer Case Components

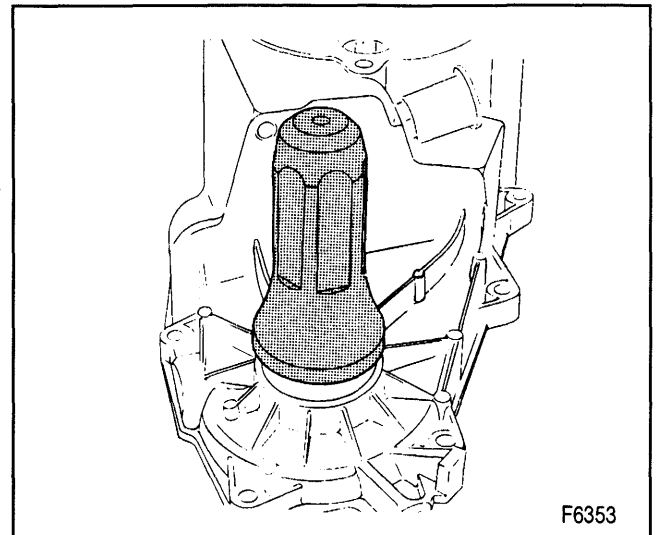
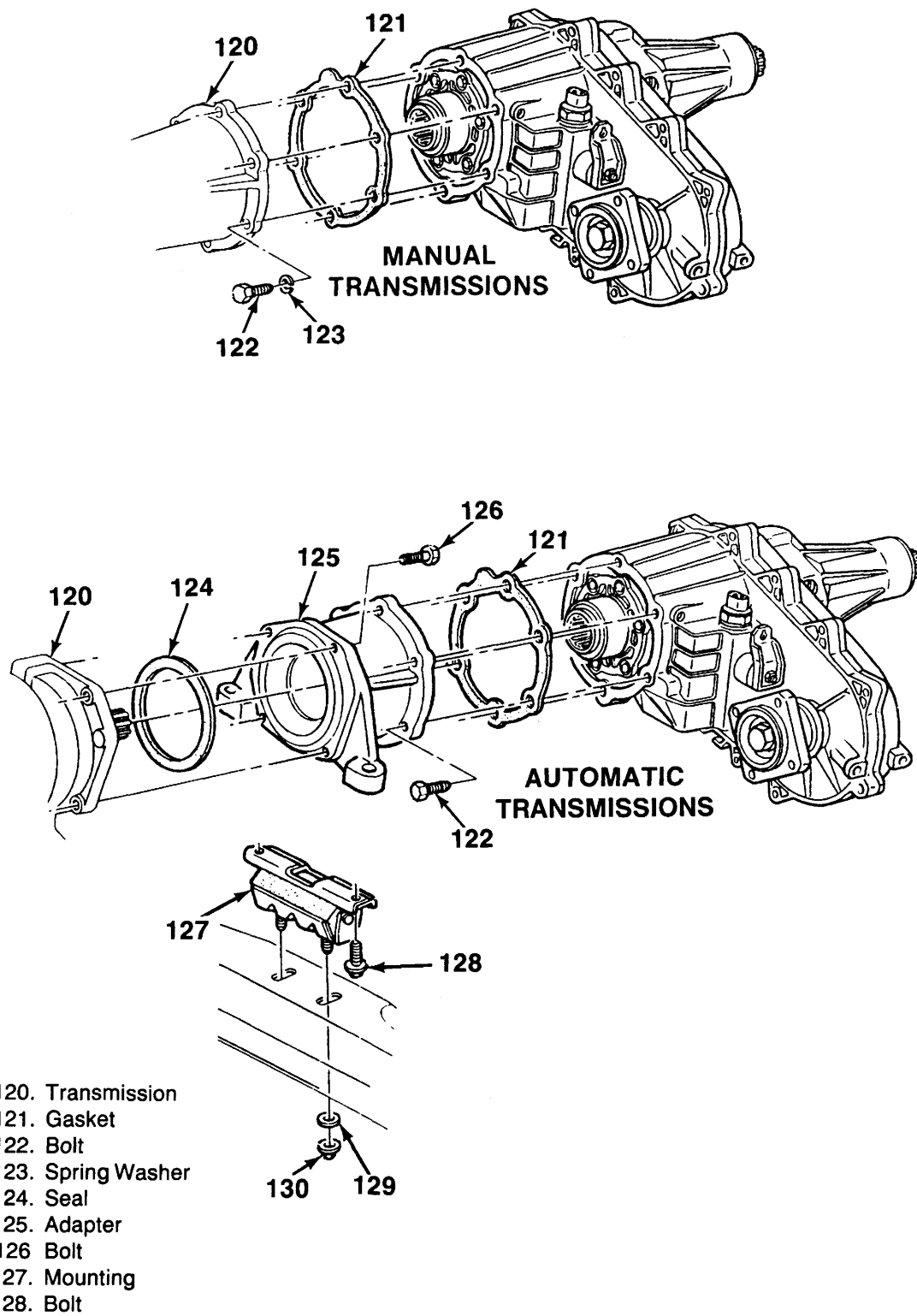


Figure 10—Installing the Output Shaft Oil Seal

7D-12 TRANSFER CASE



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Figure 11—Transfer Case Installation

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

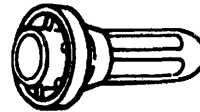
Item	N·m	Lbs. Ft.	Lbs. In.
Adapter to Transfer Case Bolts (Automatic Trans.)	45	33	—
Adapter to Transmission Bolts (Automatic Trans.)	45	33	—
Console Screws	1.4	—	12
Clutch Coil Relay Screws	2.8	—	25
Drain and Fill Plugs	25	18	—
Extension Housing Bolts (NP 241)	31	23	—
Front Propeller Shaft Yoke Nut (B-W 4401 and 4470)	225	165	—
Mounting to Transfer Case Bolts (Automatic Trans.)	47	35	—
Propeller Shaft Yoke Nut (NP 241)	149	110	—
Pump Retainer Housing Bolts (NP 241)	40	30	—
Rear Propeller Shaft Yoke Nut (B-W 4401 and 4470)	170	125	—
Shift Lever to the Floor Bolts	11	—	97
Transfer Case to Transmission Bolts (Manual Trans.)	33	24	—

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SPECIAL TOOLS

1. FRONT OUTPUT SHAFT SEAL INSTALLER
(NP 241 TRANSFER CASE)
2. REAR OUTPUT SHAFT SEAL INSTALLER
(NP 241 TRANSFER CASE)
3. OUTPUT SHAFT SEAL INSTALLER
(BW 4401 AND 4470 TRANSFER CASE)

- 1.
- 2.
- 3.



- J 29162
J 29162
J 37666-A

V2654

NOTES

SECTION 8B

LIGHTING SYSTEMS

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals, make sure the ignition switch and headlamp switch are in the OFF position. In cases where the circuit would still be “live” or “hot at all times,” disconnect the negative battery cable. This is to help prevent personal injury and/or damage to the vehicle or components.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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8B-2 LIGHTING SYSTEMS

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GENERAL DESCRIPTION

LIGHTING SYSTEMS

When diagnosing a system, keep in mind that a problem in one circuit may show up in other circuits because of a common junction. Also, several lighting circuits may have a common switch and fuse.

To become familiar with wiring systems, refer to the electrical diagnosis section of NATP-9442. The diagrams will be helpful in tracing circuits and diagnosing lighting system problems.

Periodically verify that all wiring connections are clean and tight, that lighting units are tightly mounted to provide a good ground, and that headlamps are properly

adjusted. High resistance from loose or corroded connections may cause a discharged battery, difficult starting, dim lamps, and possible damage to the generator and its regulator.

Wires and/or harnesses must be replaced if insulation is burned, cracked, or deteriorated. When it is necessary to splice a wire or repair one that is broken, use rosin flux solder to bond the splice and cover all splices and bare wires with splicing tape. By referring to applicable wiring diagrams in the electrical diagnosis section of NATP-9442, circuits may be tested for continuity and shorts with a voltmeter or an circuit powered test lamp.

DESCRIPTION OF EXTERIOR FRONT LIGHTING

FOG LAMP SYSTEM

Fog lamps are optional. The fog lamp circuit is controlled by a switch located on the instrument panel to the right of the steering column and a relay (figures 1, 2, 3, and 6). The ORN/BLK wire at the relay is hot at all times. When the fog lamp switch is turned on, the coil in the fog lamp relay is energized and the relay switch closes, completing the circuit to the fog lamps. An indi-

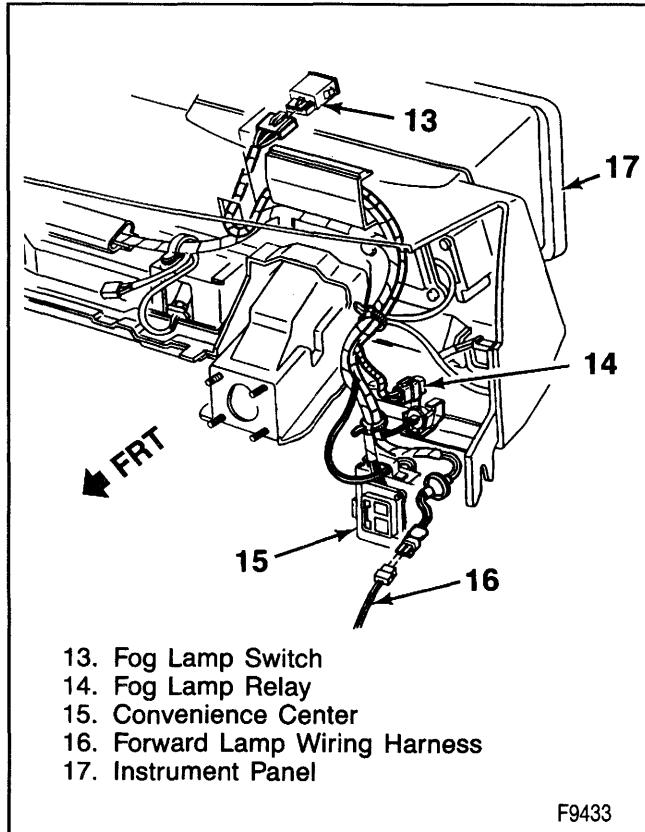


Figure 1—Fog Lamp Wiring

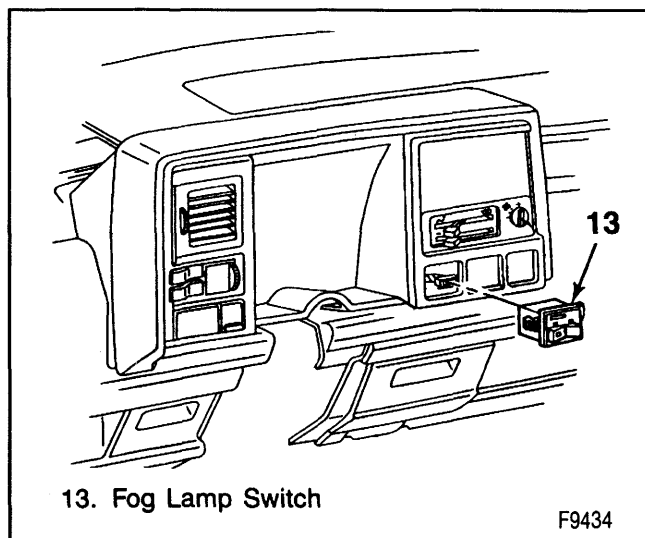


Figure 2—Fog Lamp Switch

cator lamp in the fog lamp switch turns on when the fog lamps are on.

The parking lights or the low beam headlamps must be on before the fog lamps can be turned on.

If the headlamp dimmer switch is turned to the high beams, voltage is applied to the fog lamp switch through the LT GRN wire. The ON/OFF logic in the fog lamp switch will open the coil circuit, shutting off power to the lamps.

The fog lamp circuit and switch are protected by the 30-amp ACC/CB circuit breaker and 5-amp PANEL LPS fuse.

HEADLAMP SYSTEM

The headlamps are controlled by the headlamp switch located on the left side of the instrument panel. The switch has an internal self-resetting circuit breaker that opens when the headlamp circuit draws too much current. When the circuit breaker cools, it closes again.

If the ignition is off and the headlamps are on, a warning tone will sound as a reminder to turn the lamps off. Refer to the electrical diagnosis section of NATP-9442 for diagnosis of the reminder system.

Sealed beam halogen headlamps are standard equipment. Rectangular composite headlamps with halogen bulbs are optional.

The headlamp harness routes from the fuse block to the lamp switches, then to the left side of the engine compartment and across the lower radiator support (figures 4 and 5).

The headlamp high and low beams are controlled by the dimmer switch located on the steering column. Refer to SECTION 3F1 or 3F2 for service information on the dimmer switch.

HEADLAMPS WITH DAYTIME RUNNING LIGHTS (CANADA ONLY)

Canadian vehicles are equipped with daytime running lights (DRL). This system is designed to turn on the high beam headlamps at reduced brightness any time the ignition switch is in the RUN position and the parking brake is released. If the headlamp switch is turned on, the DRL system is disconnected by the DRL module, and the headlamps operate normally.

When the daytime running lamps are on, an indicator lamp will turn on in the instrument cluster for 2 reasons: as an indicator that DRL is operating, and as a reminder to turn on the headlamps after dusk.

Voltage is applied at all times to the DRL relay through the DRL fuse and ORN wire (figures 6 and 7). When the ignition switch is in the RUN position, voltage is applied through the GAGES fuse and the PNK/BLK wire. When the coil is energized, the switch in the relay closes, and current flows through the DK BLU/WHT wire to the high beam of the left headlamp, through the LT GRN wire to the high beam of the right headlamp and ground. This puts the high beam lamps in series.

The DRL module controls the relay to prevent the daytime running lamps from turning on when the parking brake is applied, when the engine is being cranked,

8B-4 LIGHTING SYSTEMS

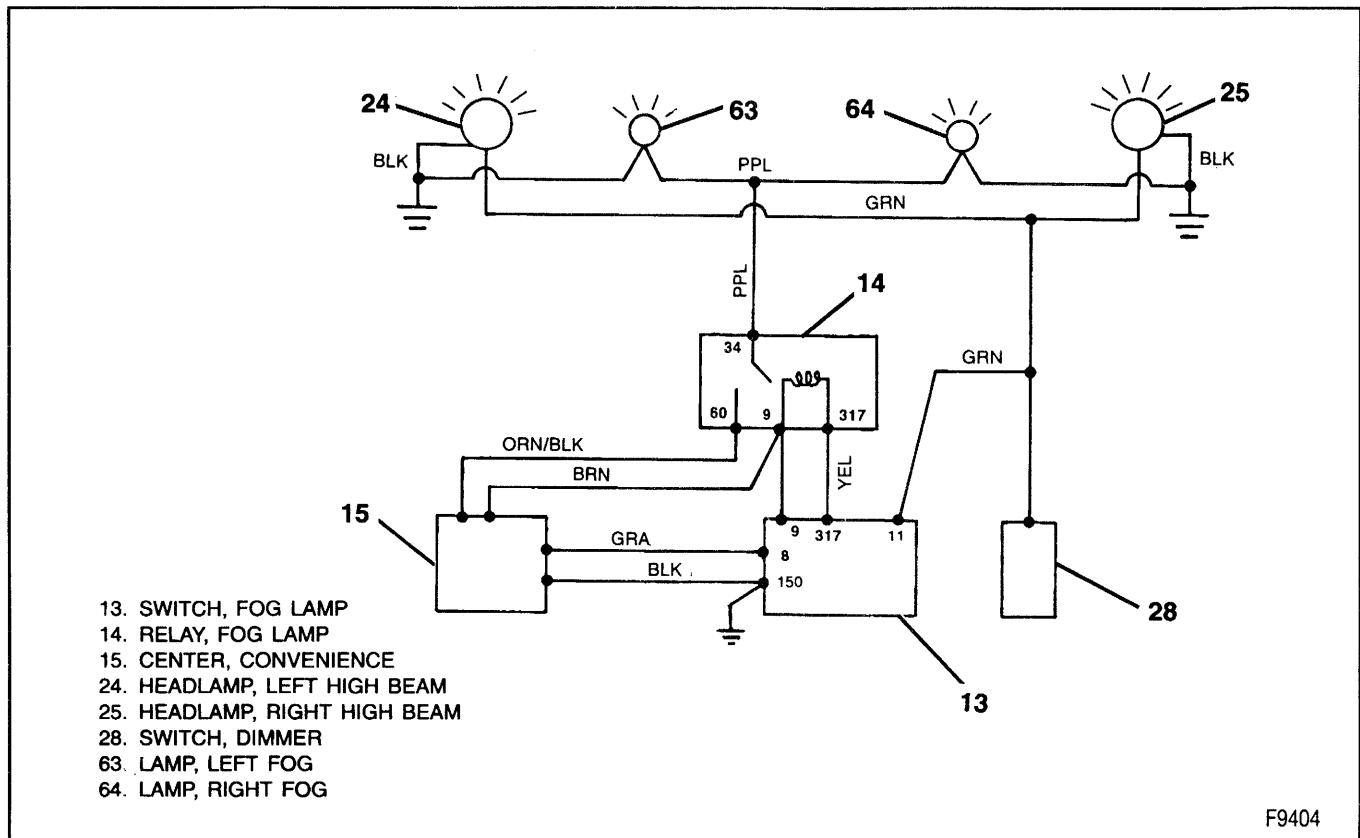


Figure 3—Fog Lamp Circuit

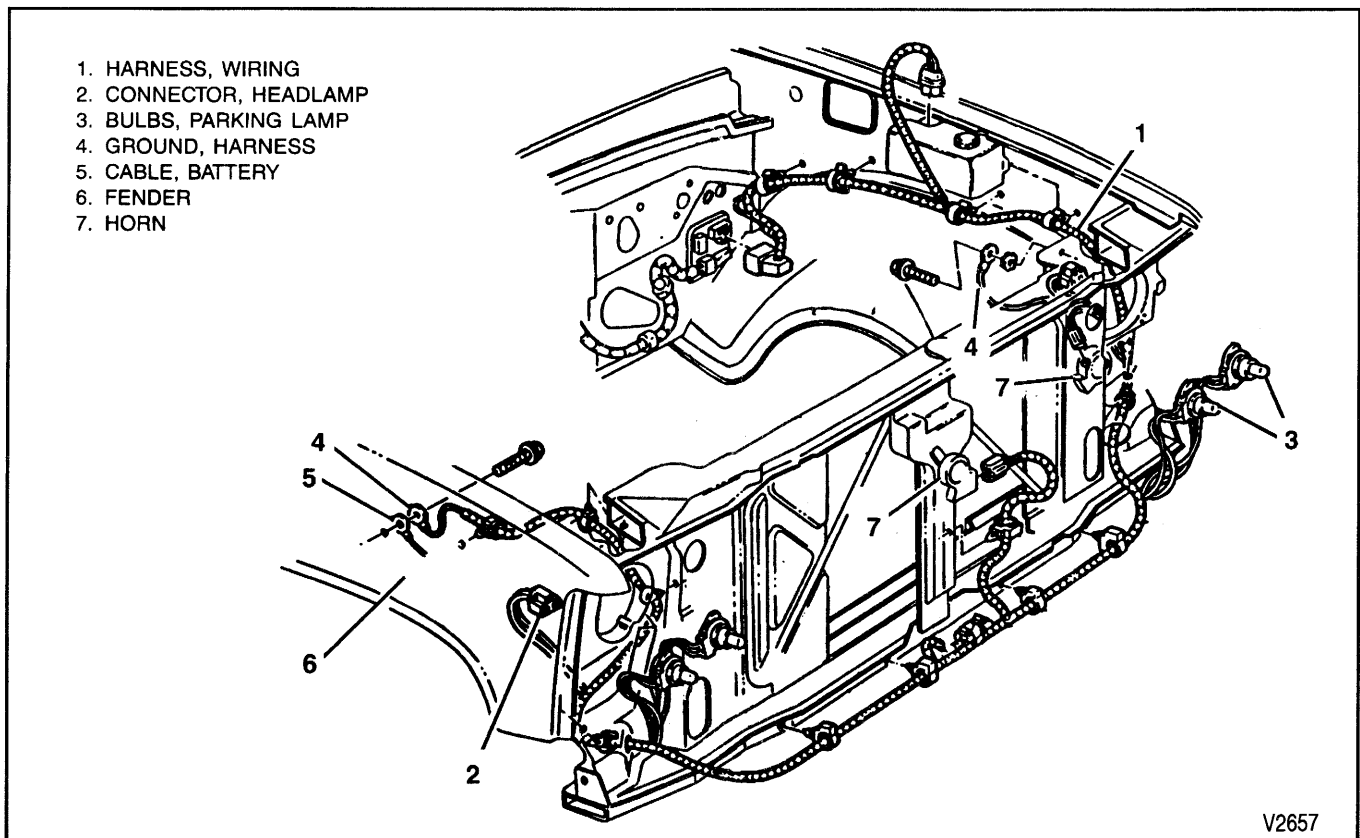


Figure 4—Forward Lamp Harness (Sealed Beam Headlamps)

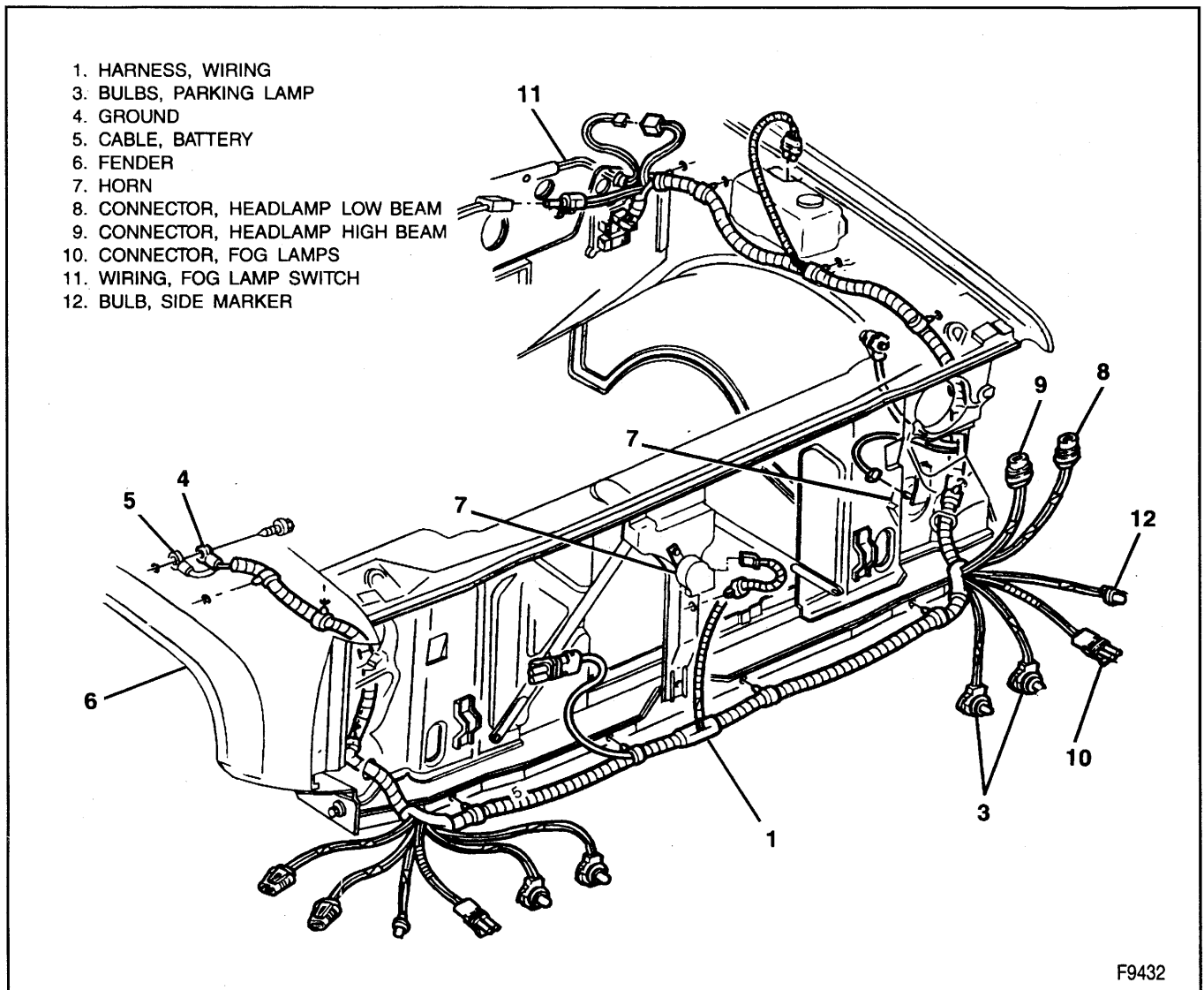


Figure 5—Forward Lamp Harness (Composite Headlamps and Fog Lamps)

or when the headlamp switch is turned on. It does this by controlling the ground side of the relay coil (LT GRN/BLK wire) and the ground side of the relay switch (BLK wire). Voltage is applied to the DRL module when the ignition switch is in RUN through the BRN wire from the A/C HTR fuse (suburban/utility) or the PNK/BLK wire (pickups and cab/chassis). The module grounds the relay through the LT GRN/BLK wire, and the DRL indicator lamp in the instrument cluster turns on.

If the parking brake is applied, the DRL module senses this through the TAN/WHT wire. If the engine is cranked, voltage will not be applied through the BRN wire. In either instance, the DRL module will not switch the LT GRN/BLK wire from the relay to ground, so the relay will not energize.

The DRL module is also part of the headlamp circuit. The headlamp wiring and dimmer switch wiring connect to the module through the YEL wire and the LT GRN wire. When the headlamp switch is turned on, the module senses battery voltage at the YEL wire and will not connect the LT GRN relay wire to ground. With the

relay de-energized, the headlamps operate normally. However, ground for the left headlamp is provided through the DK BLU/WHT wire, the normally closed contacts of the DRL relay, and the BLK wire.

The DRL module is located behind the left side of the instrument panel and is taped to the instrument panel wiring harness.

TURN SIGNAL RELAYS (SNOW PLOW APPLICATION)

Two relays mount to the radiator support when the vehicle is equipped with the snow plow option (figure 8). The circuit starts at the battery junction block. Voltage is supplied at all times to the switch in each relay. When the turn signal lever is turned to the left or right, the coil in the left or right relay energizes, and the switch closes, providing voltage to the snow plow turn signal. The coil in the left relay grounds at the sheet metal above the left headlamp. The coil in the right relay grounds at the right fender near the battery.

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8B-6 LIGHTING SYSTEMS

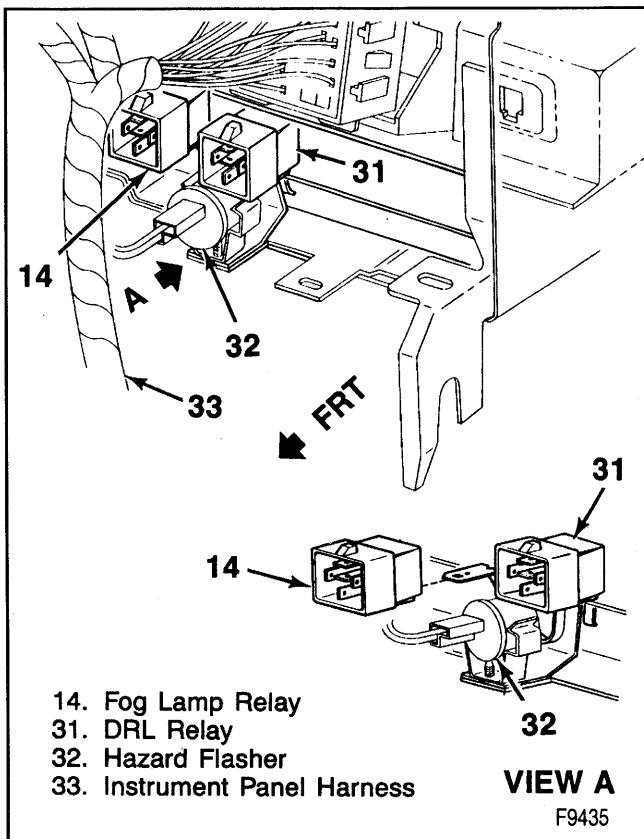


Figure 6—DRL Relay and Fog Lamp Relay

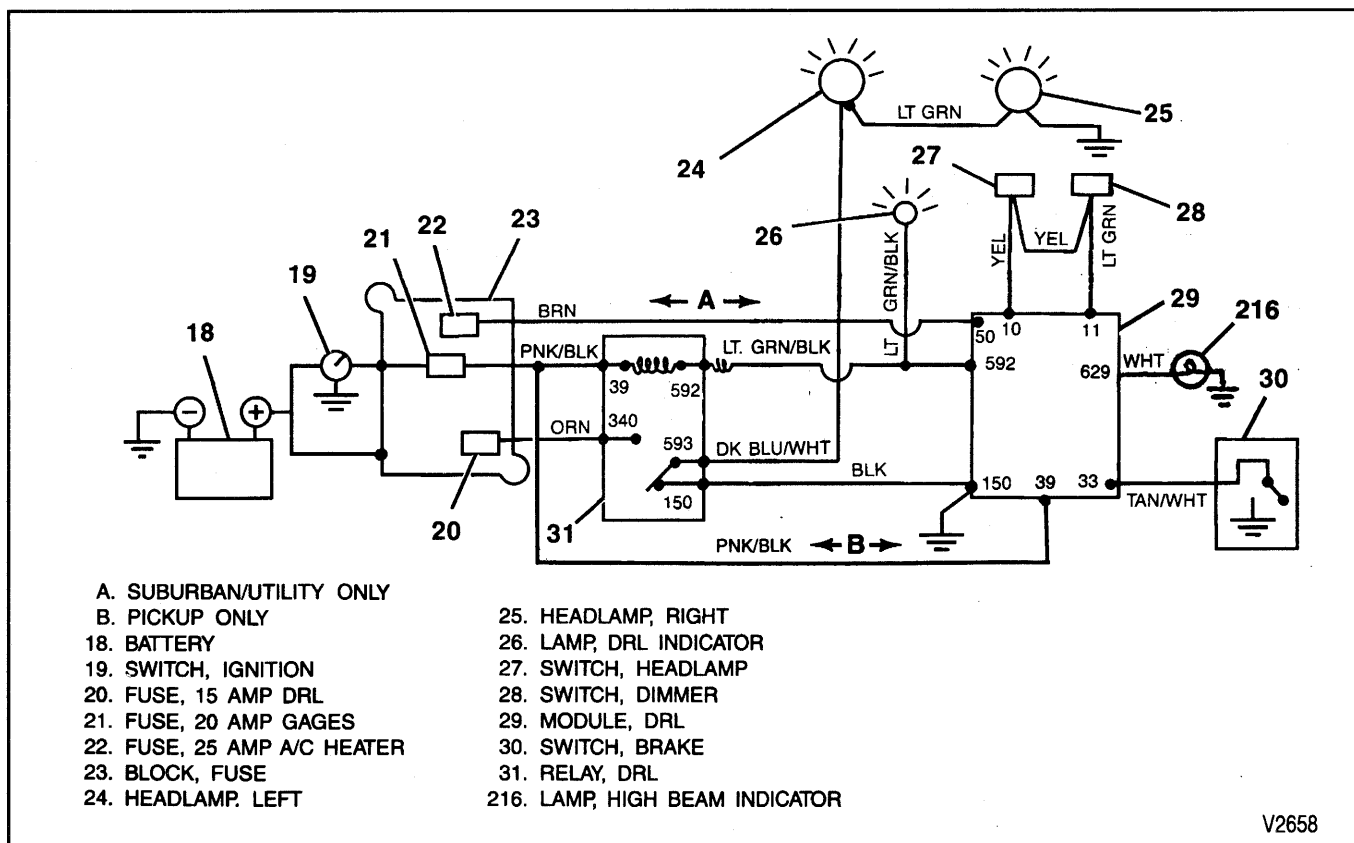


Figure 7—DRL Schematic

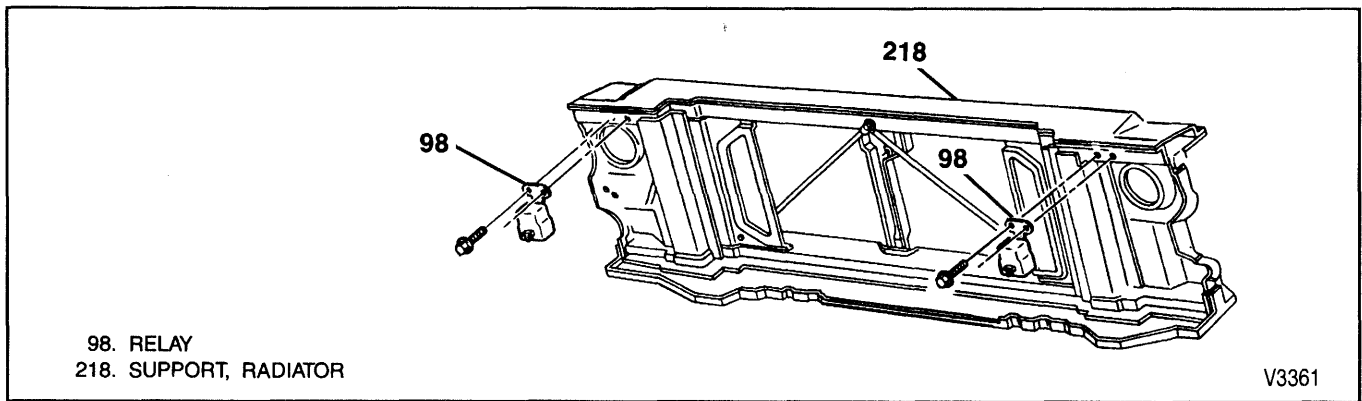


Figure 8—Snow Plow Relays

DESCRIPTION OF EXTERIOR REAR LIGHTING

BACKUP LAMP SYSTEM

The backup lamp system consists of the backup switch and the backup lamp circuit. The circuit is protected by the 15-amp TURN/BU fuse. The backup switch is located on the steering column for automatic transmissions (figure 9) and on the left side of the transmission for manual transmissions.

The backup lamps are turned on when the transmission is shifted into reverse. The backup lamps are located in the rear lamp assemblies. Refer to SECTION 7B for service information on the transmission-mounted switch (manual transmission only). Refer to SECTION 3F for service information on the steering column-mounted switch (automatic transmission only).

HAZARD FLASHER SYSTEM

The hazard flasher system consists of a hazard switch that is mounted on the lower right side of the steering column, and a hazard flasher unit mounted below the instrument panel (figures 6 and 10). The circuit is protected by the 15-amp STOP/HAZ fuse in the fuse block. Refer to SECTION 3F1 or 3F2 for service information on the hazard switch.

LICENSE LAMP CIRCUIT

The license lamp circuit branches from the rear lamp harness at the rear corner of the vehicle. The license lamp turns on when the park lamp switch or headlamp switch is turned on.

MARKER, PARK, AND TAILLAMP SYSTEM

The marker lamp system consists of marker lamps that are located at each corner of the vehicle. The marker lamps have wrap-around lenses, that enable the lamps to function as parking lamps in front and tail-lamps in the rear.

The marker lamps are turned on when the parking lamp switch or the headlamp switch is turned on. The front harness of this system routes along the left side of the engine compartment and along the bottom of the radiator support. The rear harness is routed from the bulkhead connector in the engine compartment to the

frame then along the left frame rail to the rear panel. The rear lamp harness connects inside the back of the frame rail.

ROOF MARKER LAMPS

The roof marker lamp harness starts at the convenience center, is taped to the back of the cowl, then runs up the side of the door pillar and through two holes in the door pillar and the roof frame to the roof marker lamps. The harness is covered by the roof garnish molding and the roof trim panel. The circuit is protected by the 20-amp PARK LP fuse.

STOPLAMP SYSTEM

The stoplamp system consists of a non-adjustable stop switch connected to the rear taillamps circuit. Pick-up and cab/chassis models have a combination cargo/stoplamp mounted on the rear of the cab. Suburban and utility models have an LED stoplamp screwed to the roof, above the rear doors. The LED stoplamp is not serviceable and must be replaced if diagnosis leads to a faulty lamp assembly. Refer to the electrical diagnosis section of NATP-9442 for stoplamp diagnosis.

The circuit is protected by the 15-amp STOP fuse. The stop switch is located at the upper end of the brake pedal lever (figure 11). Refer to SECTION 5 for service information on the stop switch.

TURN SIGNAL SYSTEM

The turn signal system consists of the turn signal switch, the flasher unit, the turn lamps located at each corner of the vehicle, and indicator lamps in the instrument cluster. When the turn signal switch is positioned for left or right turn, the left or right turn lamps connect to the flasher unit. Current flows through the flasher unit, to the lamps, and ground. The flasher unit turns on and off, causing the lamps to flash.

The turn signal switch mounts on the steering column, a flasher unit mounts under the instrument panel in the upper left corner of the convenience center, and a harness connects the front turn lamps and rear tail-lamps (figure 10). The circuit is protected by the 15-amp TURN/BU fuse in the fuse block. Refer to SECTION 3F1 or 3F2 for service information on the turn signal switch.

8B-8 LIGHTING SYSTEMS

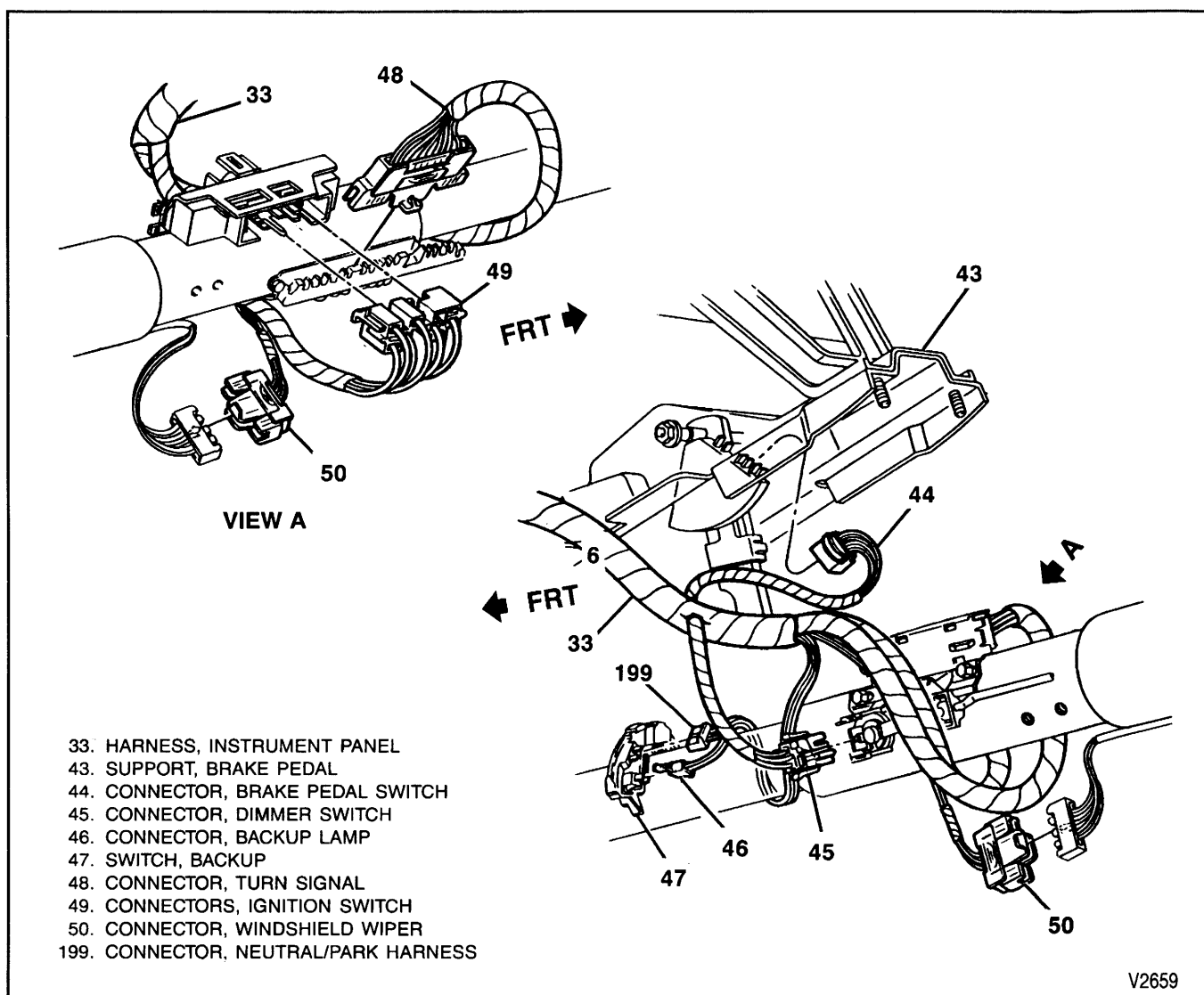


Figure 9—Steering Column Connectors

UNDERHOOD LAMPS

The underhood reel lamp harness runs from the junction block on the engine side of the cowl to the reel lamp along the right side inner fender. The underhood stationary lamp is located on the hood, and supplied from the junction block. Both lamps have an in-line 5-amp fuse and are grounded to a relay bracket at the junction block.

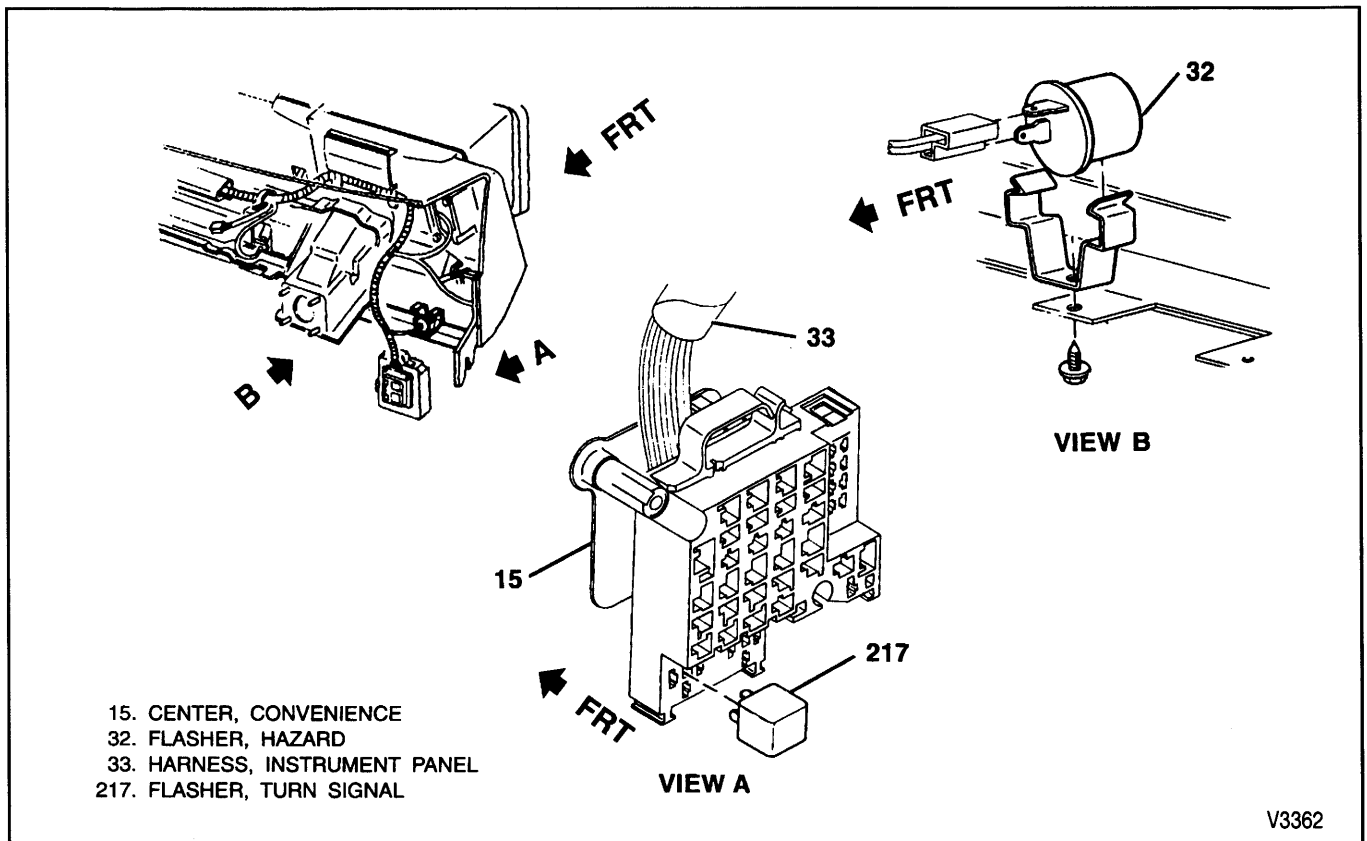


Figure 10—Hazard and Turn Signal Flashers

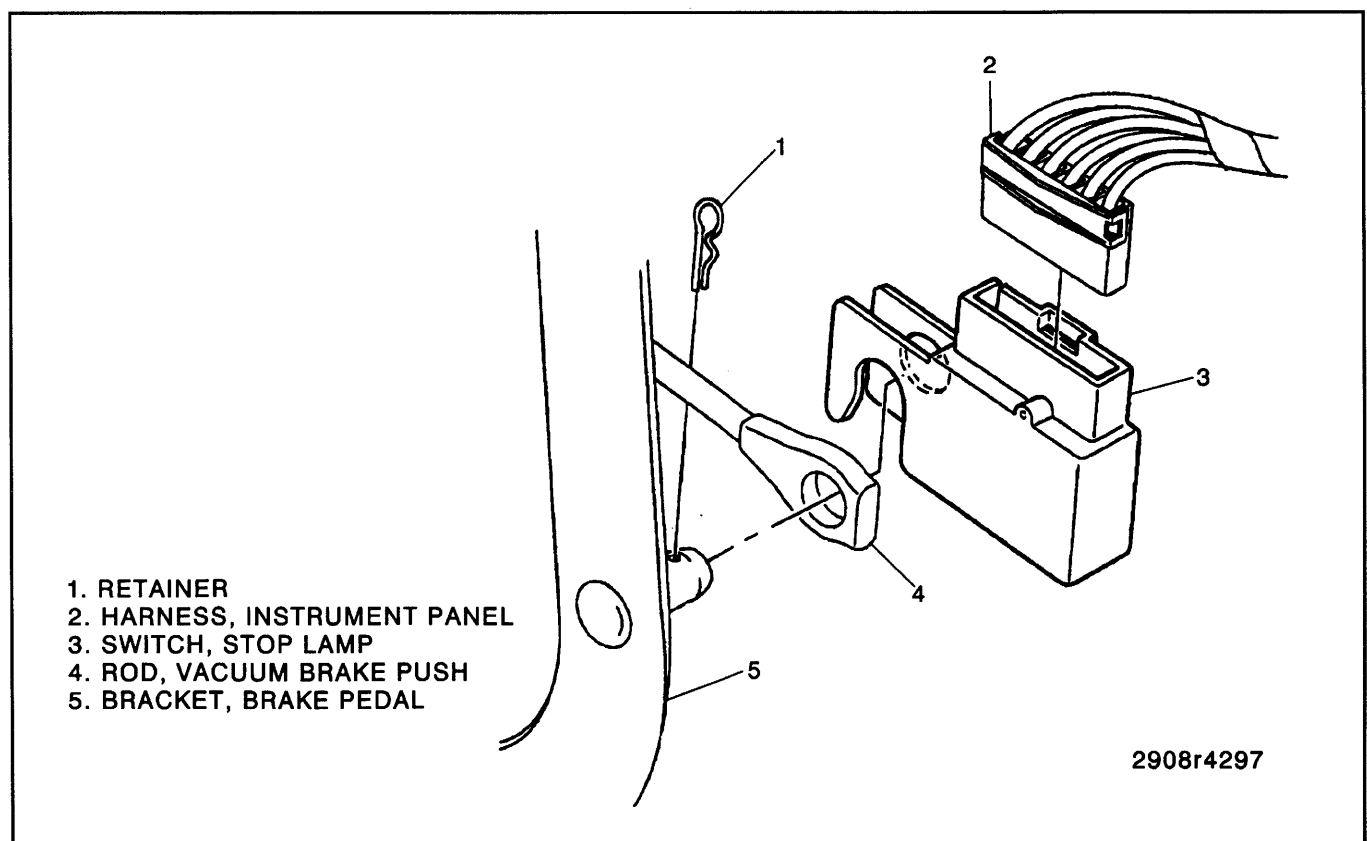


Figure 11—Stop Switch

DESCRIPTION OF INTERIOR LIGHTING

CARGO LAMP SYSTEM

Pickup and cab/chassis models have a combination cargo/stoplamp.

The cargo lamp front harness starts at the convenience center and routes to the cargo lamp switch on the left side of the instrument panel (figure 12). The rear harness is wired from the convenience center through the body wiring conduit inside the left door opening, then behind the body side trim panel, and up

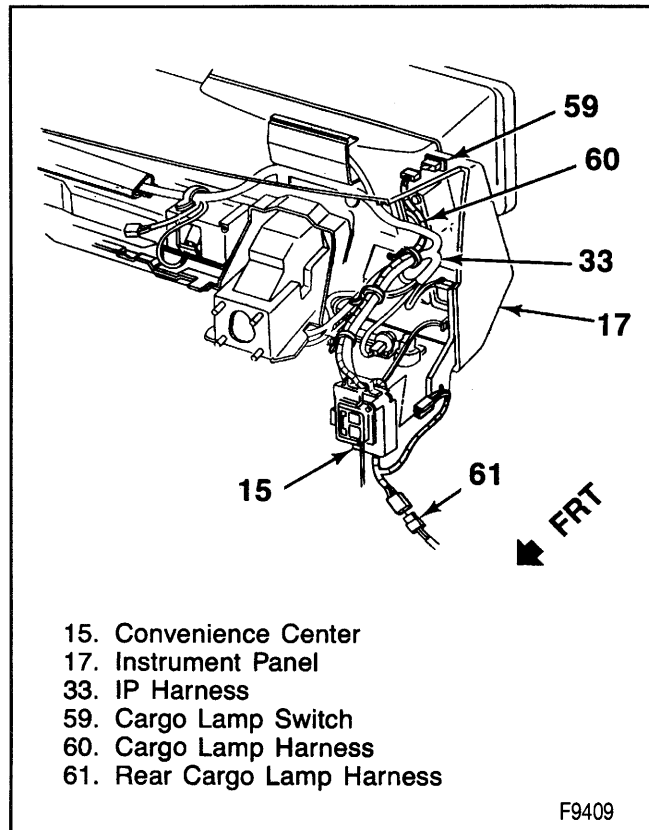


Figure 12—Cargo Lamp Switch Wiring

and across the roof above the roof inner panel (figure 13). The circuit is protected by the 20-amp CTSY fuse and grounds to the data link connector bracket behind the left side of the instrument panel.

DOME LAMP SYSTEM

The dome lamp is controlled by the door jamb switches and the instrument panel dimmer switch. The dome lamp and courtesy lamps under the instrument panel will turn on whenever a door is opened or the dimmer switch is turned past the detent all the way to the right.

The dome lamp harness starts at the convenience center and routes along the left kick panel to the floor, along the floor through the body wiring conduit, up the left side of the cab behind the body molding, and along the roof behind the roof inner trim panel (figures 14, 15, and 16). The harness is protected by the 20-amp CTSY fuse and is grounds to the data link connector bracket under the left side of the instrument panel.

An optional dome lamp override switch can be turned off to prevent the dome and courtesy lamps from turning on when a door jamb switch closes (door opens).

INSTRUMENT PANEL LAMP SYSTEM

The wiring harness for the instrument panel lamps starts at the convenience center and routes from left to right through the conduit behind the instrument panel (figure 17). The harness grounds to the data link connector bracket behind the left side of the instrument panel. The instrument panel compartment lamp and courtesy lamps are protected by the 20-amp CTSY fuse. The ashtray lamp and cigarette lighter lamps are protected by the 20-amp PARK LP fuse. The lamps for the instrument cluster, radio, and switches are protected by the 5-amp PNL LP fuse.

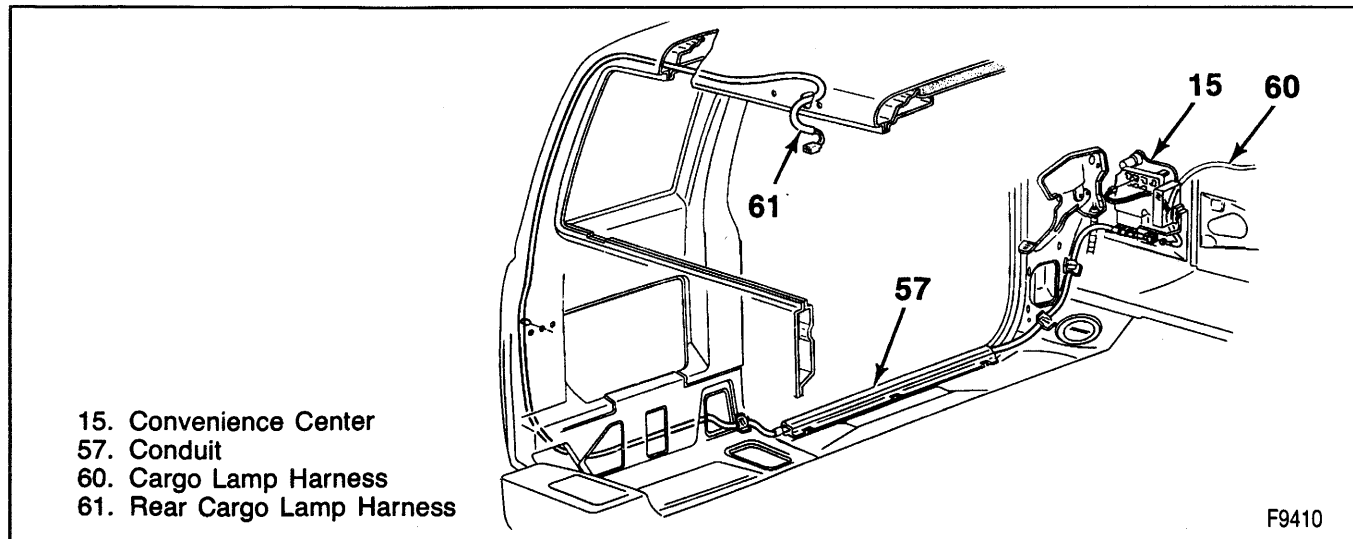


Figure 13—Rear Cargo Lamp Wiring

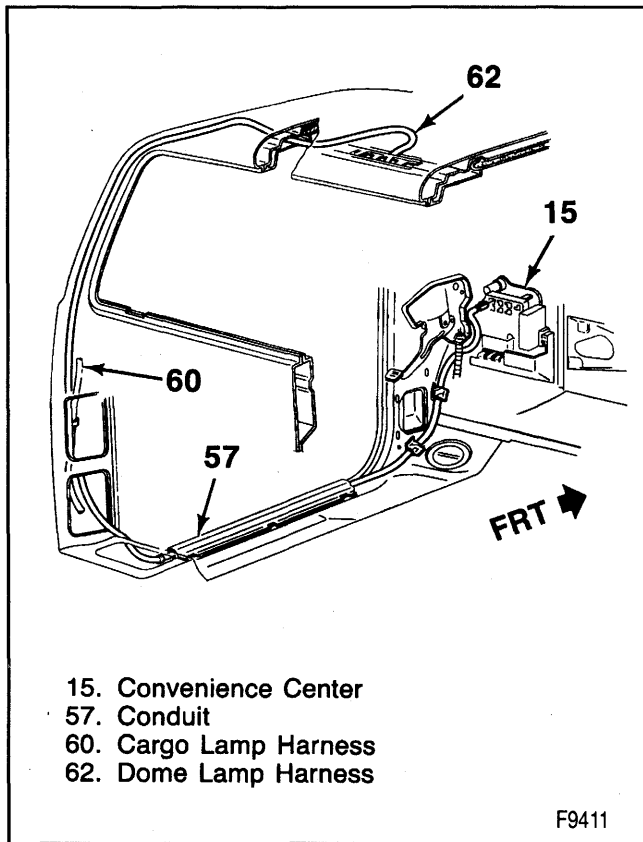


Figure 14—Dome Lamp Harness

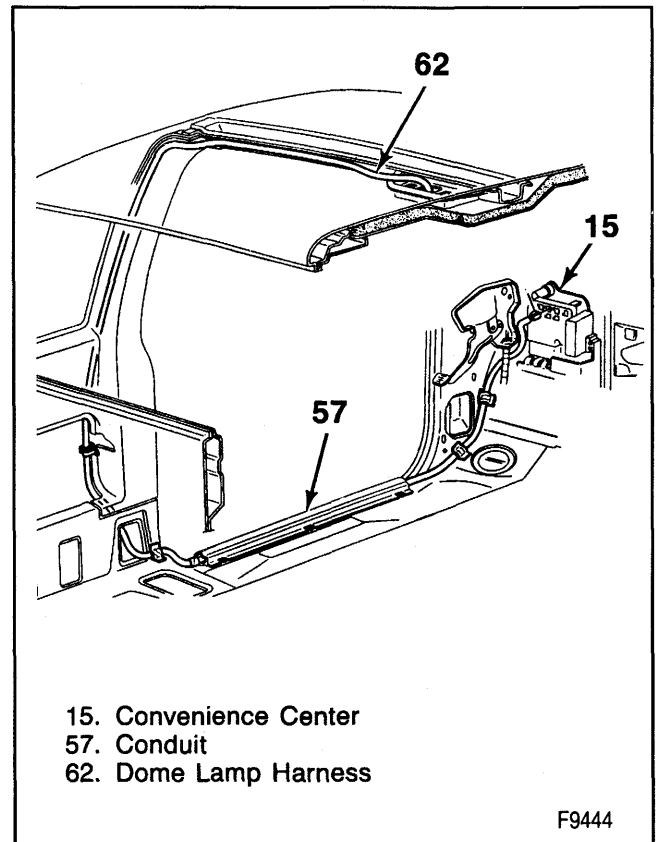


Figure 15—Dome Lamp Harness (Extended Cab)

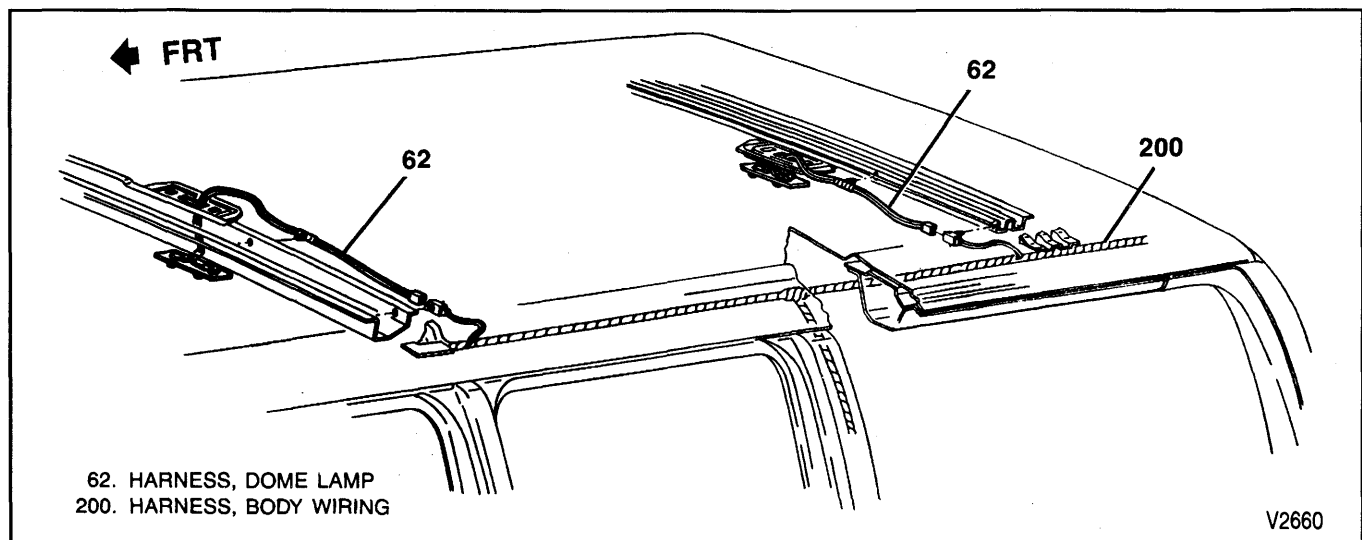


Figure 16—Dome Lamp Harness Extension (Utility Vehicle and Suburban)

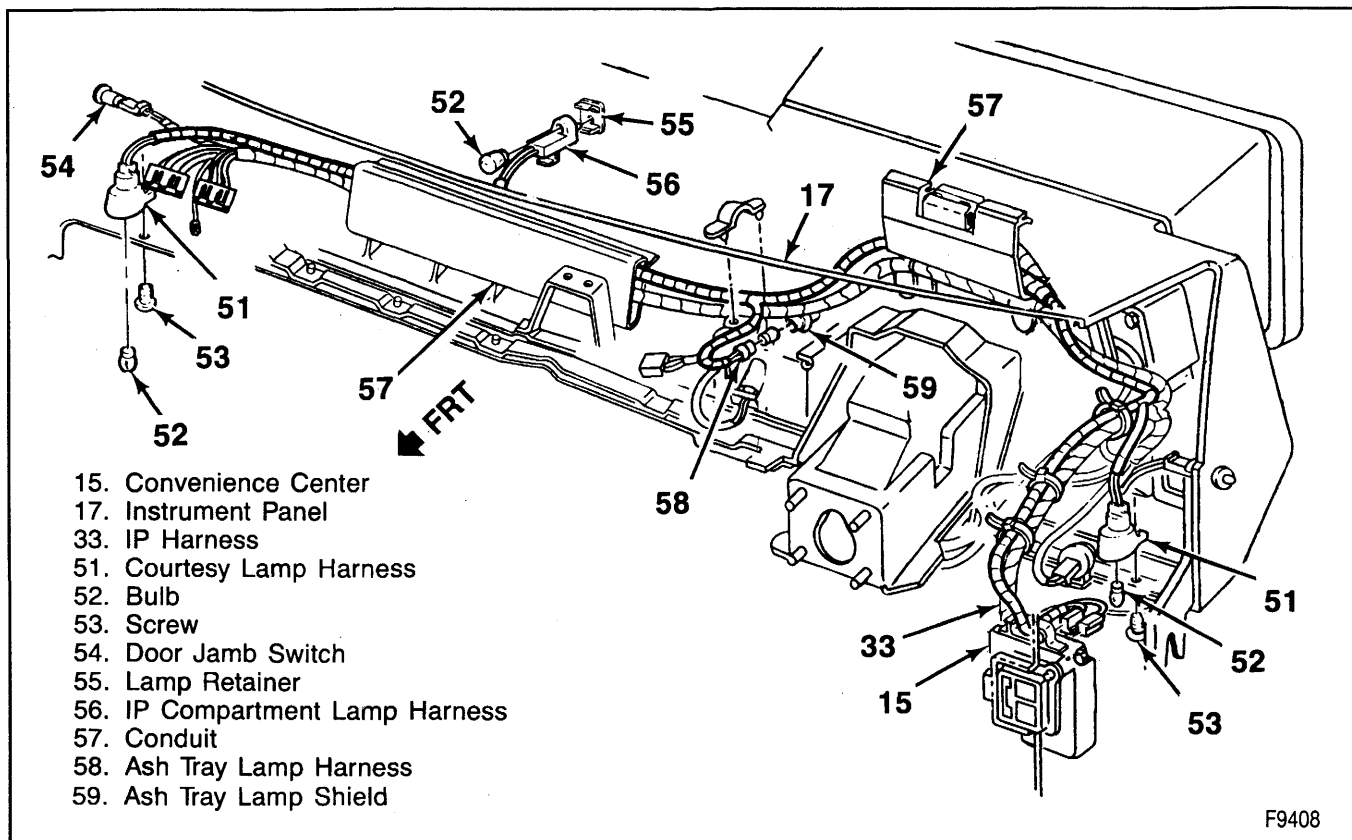


Figure 17—Instrument Panel Lamps

DIAGNOSIS OF LIGHTING SYSTEMS

For complete circuit views, including splices and connectors, refer to the electrical diagrams section of NATP-9442.

DIAGNOSIS OF THE BACKUP LAMPS

BACKUP LAMPS DO NOT OPERATE

TEST	RESULT	ACTION
1. Place the transmission in reverse. Connect a test lamp from the light green wire to the black wire at each backup lamp connector.	Test lamp lights.	Replace the bulb.
	Test lamp does not light.	Locate and repair the open in the black wire from the backup lamp connector to ground.
2. Connect a test lamp from the dark blue wire at the backup lamp switch connector at the transmission (manual) or on the steering column (auto).	Test lamp lights.	Go to step 3.
	Test lamp does not light.	Check the condition of the TURN-B/U fuse. If the fuse is good, locate and repair the open in the dark blue wire from the backup lamp switch to the fuse block.
3. Connect the test lamp from the light green wire at the backup lamp switch connector to ground.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Adjust the backup lamp switch. If the switch will not adjust properly, replace it.

DIAGNOSIS OF THE BACKUP LAMPS

4. Connect the test lamp from the light green wire at the connector at the bulkhead in the engine compartment to ground.	Test lamp lights.	Go to step 5.
	Test lamp does not light.	Locate and repair the open in the light green wire between the back-up lamp switch connector and the connector at the crossmember.
5. Connect the test lamp from the light green wire at the connector at the left rear crossmember to ground.	Test lamp lights.	Locate and repair the open in the light green wire between the connector and the splice at the left rear lamp harness.
	Test lamp does not light.	Locate and repair the open in the light green wire between the connector at the bulkhead and the connector at the left rear crossmember.

T2892

DIAGNOSIS OF THE FOG LAMPS

FOG LAMPS DO NOT OPERATE

TEST	RESULT	ACTION
1. Place the fog lamp switch ON and the headlamp switch OFF. Connect a test lamp from the purple wire at the fog lamp relay connector to ground.	Test lamp lights.	Locate and repair the open in the purple wire from the fog lamp relay to the fog lamps.
	Test lamp does not light.	Go to step 2.
2. Connect the test lamp from the orange/black wire at the fog lamp relay connector to ground.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Go to step 3.
3. Connect the test lamp from the orange/black wire at the convenience center to ground.	Test lamp lights.	Locate and repair the open in the orange/black wire from the fog lamp relay connector to the convenience center.
	Test lamp does not light.	Check the condition of the PWR ACC circuit breaker. If circuit breaker is good, locate and repair the open in the orange/black wire between the convenience center and fuse block.
4. Connect the test lamp from the brown wire at the fog lamp relay connector to ground.	Test lamp lights.	Go to step 7.
	Test lamp does not light.	Go to step 5.
5. Connect the test lamp from the brown wire at the convenience center to ground.	Test lamp lights.	Locate and repair the open in the brown wire between the convenience center and the fog lamp relay connector.
	Test lamp does not light.	Go to step 6.
6. Place the headlamp switch in PARK. Observe the taillamps.	Taillamps are on.	Locate and repair the open in the brown wire between the convenience center and the splice under the left side of the instrument panel.
	Taillamps are off.	Locate and repair the open in the brown wire between the headlamp switch connector and the splice.
7. Connect a test lamp from the yellow wire at the fog lamp relay connector to ground.	Test lamp lights.	Replace the fog lamp relay.
	Test lamp does not light.	Go to step 8.

DIAGNOSIS OF THE FOG LAMPS

8. Connect the test lamp from the yellow wire at the fog lamp switch to ground.	Test lamp lights.	Locate and repair the open in the yellow wire between the fog lamp switch and fog lamp relay connector.
	Test lamp does not light.	Go to step 9.
9. Connect the test lamp from the black wire at the fog lamp switch connector to ground.	Test lamp lights.	Replace the fog lamp switch.
	Test lamp does not light.	Go to step 10.
10. Connect the test lamp from the black wire at the convenience center to ground.	Test lamp lights.	Locate and repair the open in the black wire between the convenience center and the fog lamp switch connector.
	Test lamp does not light.	Go to step 11.
11. Turn on the radio.	Radio operates.	Locate and repair the open in the black wire between the convenience center the the splice under the left side of the instrument panel.
	Radio does not operate.	Locate and repair the open in the black wire between the splice and ground at the data link connector.

T2891

DIAGNOSIS OF THE FRONT PARK AND SIDE MARKER LAMPS**FRONT PARK AND SIDE MARKER LAMPS DO NOT OPERATE**

TEST	RESULT	ACTION
1. Place the headlamp switch in the PARK position. Connect a test lamp from the orange wire at the headlamp switch to ground.	Test lamp lights.	Go to step 3.
	Test lamp does not light.	Go to step 2.
2. Push the horn button.	Horn sounds.	Locate and repair the open in the orange wire between the headlamp switch and the splice under the left side of the instrument panel.
	Horn does not sound.	Check the condition of the PARK LP fuse. If the fuse is good, locate and repair the open in the orange wire from the fuse block to the splice.
3. Connect the test lamp from the brown wire at the headlamp switch to ground.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Replace the headlamp switch.
4. Connect the test lamp from the brown wire at the cowl in the engine compartment to ground.	Test lamp lights.	Locate and repair the open in the brown wire between the splice and the connector near the left headlamp.
	Test lamp does not light.	Locate and repair the open in the brown wire from the connector at the cowl and the headlamp switch.

T2893

DIAGNOSIS OF THE HAZARD SYSTEM

HAZARD LAMPS DO NOT OPERATE

TEST	RESULT	ACTION
1. Check the condition of the STOP-HZ fuse.	Fuse is not blown.	Go to step 2.
	Fuse is blown.	Locate and repair the source of the overload. Then, replace the fuse.
2. Place the ignition switch in RUN and position the turn signal lamps as if making a turn.	Turn signal lights operate.	Go to step 3.
	Turn signal lights do not operate.	Replace the turn signal switch.
3. Turn off the turn signal lamps and put the hazard warning lamps on. Connect a test lamp from the brown wire at the turn signal switch connector to ground.	Test lamp flashes.	Replace the turn signal switch.
	Test lamp does not flash.	Go to step 4.
4. Connect the test lamp from the brown wire at the hazard flasher connector to ground.	Test lamp flashes.	Locate and repair the open in the brown wire between the hazard flasher connector and the turn signal switch connector.
	Test lamp does not flash.	Go to step 5.
5. Connect the test lamp from the orange wire at the hazard flasher connector to ground.	Test lamp lights.	Replace the hazard flasher.
	Test lamp does not light.	Locate and repair the open in the orange wire between the hazard flasher connector and the fuse block.

T2894

DIAGNOSIS OF THE HEADLAMPS WITHOUT DAYTIME RUNNING LIGHTS

HEADLAMPS DO NOT OPERATE—BOTH SIDES

TEST	RESULT	ACTION
1. Connect a test lamp from the red wire at the headlamp switch connector to ground.	Test lamp lights.	Go to Step 3.
	Test lamp does not light.	Go to Step 2.
2. Connect the test lamp from the red wire connector at the cowl to ground.	Test lamp lights.	Locate and repair the open in the red wire from the headlamp switch to the connector at the cowl.
	Test lamp does not light.	Locate and repair the open in the red wire or fusible link between the connector and the battery junction block.
3. With the headlamp switch on and the dimmer switch on high beam, connect a test lamp from the yellow wire connector at the headlamp switch to ground.	Test lamp lights.	Go to Step 4.
	Test lamp does not light.	Replace the headlamp switch.
4. Connect the test lamp from the yellow wire connector at the dimmer switch to ground.	Test lamp lights.	Replace the headlamp dimmer switch.
	Test lamp does not light.	Repair the open in the yellow wire from the headlamp dimmer switch to the headlamp switch.

DIAGNOSIS OF THE HEADLAMPS WITHOUT DAYTIME RUNNING LIGHTS

LOW BEAM LAMP(S) DO NOT OPERATE

TEST	RESULT	ACTION
1. Turn the headlamp switch on and the headlamp dimmer switch to the low beam position. Connect a test lamp from the tan wire at the inoperative lamp(s) to ground.	Test lamp does not light.	Go to Step 3.
	Test lamp lights.	Go to Step 2.
2. Connect the test lamp from the tan wire to the black wire(s) at the headlamp connectors (right dual beam lamp or right high beam lamp) or from the tan wire connector to ground (left dual beam lamp or left high beam lamp).	Test lamp does not light.	Locate and repair the open in the black wire(s) from the headlamp connector(s) to the ground terminal(s).
	Test lamp lights.	Replace the headlamp(s).
3. Connect the test lamp from the tan wire at the dimmer switch connector to ground.	Test lamp does not light.	Replace the headlamp dimmer switch.
	Test lamp lights.	Locate and repair the open in the tan wire from the headlamp dimmer switch to the headlamp.

HIGH BEAM LAMP(S) DO NOT OPERATE

TEST	RESULT	ACTION
1. Turn the headlamp switch on and the headlamp dimmer switch to the high beam position. Connect a test lamp from the light green wire at the inoperative lamp(s) to ground.	Test lamp lights.	Go to Step 2.
	Test lamp does not light.	Go to Step 3.
2. Connect the test lamp from the light green wire to the black wire(s) at the headlamp connectors.	Test lamp lights.	Replace the headlamp(s).
	Test lamp does not light.	Locate and repair the open in the black wire(s) at the headlamp connector(s) to the ground connection(s).
3. Connect a test lamp from the light green wire at the headlamp dimmer switch connector to ground.	Test lamp lights.	Locate and repair the open in the light green wire from the headlamp connector(s) to the headlamp dimmer switch connector.
	Test lamp does not light.	Replace the headlamp dimmer switch.

T2858

DIAGNOSIS OF THE HEADLAMPS WITH DAYTIME RUNNING LIGHTS

PRELIMINARY CHECKS

Turn the ignition switch to RUN and release the parking brake. Check the condition of the DRL and GAGES fuses. If either is blown, locate and repair the source of the overload. Then replace the fuse.

The DRL system operates by disconnecting one of the headlamp system grounds, turning a parallel circuit into a series circuit. If the DRL do not come on when they should, turn on the high beam headlamps. If one of them is burned out, the DRL system will not operate.

(On a vehicle with dual headlamps, each headlamp contains a high beam and low beam filament. The DRL module applies voltage to both, although the low beam filament will light only dimly. The DRL module only monitors the high beam circuit for an open, so if a low beam filament burns out, creating an open, the daytime running lights will continue to operate).

The daytime running lights may not come on unless battery voltage is close to 12 volts. If the battery voltage is about 9 volts, the vehicle may start, but the DRL may not turn on. With the engine running, apply the parking brake and then release it, or turn on the headlamp switch and then turn it off. If this causes the DRL to turn on, check the battery voltage. Refer to SECTION 6D1.

For other checks, consult the following diagnostic charts.

DAYTIME RUNNING LAMPS DO NOT OPERATE

TEST	RESULT	ACTION
1. Connect a test lamp from the orange wire at the DRL relay connector to ground.	Test lamp lights.	Go to Step 2.
	Test lamp does not light.	Locate and repair the open in the orange wire between the relay connector and the fuse block.
2. Connect the test lamp from the pink/black wire at the relay connector to ground.	Test lamp lights.	Go to Step 4.
	Test lamp does not light.	Go to Step 3.
3. Place the parking brake on. Observe the brake indicator lamp on the instrument cluster.	Test lamp lights.	Locate and repair the open in the pink/black wire between the relay connector and the splice under the left side of the instrument panel.
	Test lamp does not light.	Locate and replace the open in the pink/black wire between the splice and the fuse block.
4. Connect a test lamp from the light green/black wire at the DRL relay connector to ground.	Test lamp lights.	Go to step 5.
	Test lamp does not light.	Go to step 6.
5. Connect the test lamp from the dark blue/white wire at the relay connector to ground.	Test lamp lights.	System operating normally.
	Test lamp does not light.	Replace the DRL relay.
6. Connect a test lamp from the light green/black wire at the DRL module to ground.	Test lamp lights.	Locate and repair the open in the light green/black wire between the module and the relay.
	Test lamp does not light.	Go to step 7.
7. Connect the test lamp from the pink/black wire (pickup) or brown wire (suburban/utility) at the module to ground.	Test lamp lights.	Go to step 8.
	Test lamp does not light.	Locate and repair the open in the pink/black wire between the module to the splice under the left side of the instrument panel (pickup) or the brown wire between the module and the fuse block (suburban/utility).
8. Connect the test lamp from the black wire at the module to ground.	Test lamp lights.	Go to step 10.
	Test lamp does not light.	Go to step 9.
9. Turn on the radio.	Radio operates.	Locate and repair the open in the black wire from the module to the splice under the left side of the instrument panel.
	Radio does not operate.	Locate and repair the open in the black wire between the splice and ground at the data link connector.

DIAGNOSIS OF THE HEADLAMPS WITH DAYTIME RUNNING LIGHTS

10. Connect the test lamp from the tan/white wire at the DRL module to ground.	Test lamp lights.	Locate and repair the short to ground in the tan/white wire between the module and the parking brake switch connector. If no short is found replace the parking brake switch.
	Test lamp does not light.	Replace the DRL module.

T2889

LOW BEAM LAMP(S) DO NOT OPERATE

TEST	RESULT	ACTION
1. Place the headlamp switch in the ON position and the headlamp dimmer switch in the low beam position. Connect a test lamp from the tan wire at the inoperative lamp(s) to ground.	Test lamp lights.	Go to step 2.
	Test lamp does not light.	Go to step 6.
2. Connect the test lamp from the tan wire to the black wire at the right headlamp connector or to the dark blue/white wire at the left headlamp connector.	Test lamp lights.	Replace the headlamp(s).
	Test lamp does not light.	Locate and repair the open in the black wire from the right headlamp connector to ground. Go to step 3 for the left headlamp.
3. Connect a test lamp from the dark blue/white wire at the DRL relay connector to ground.	Test lamp lights.	Locate and repair the open in the dark blue/white wire between the relay connector C291 and the headlamp connector.
	Test lamp does not light.	Go to step 4.
4. Connect the test lamp from the black wire at the relay connector to ground.	Test lamp lights.	Replace the DRL relay.
	Test lamp does not light.	Go to step 5.
5. Turn on the radio.	Radio operates.	Locate and repair the open in the black wire between the relay connector and the splice under the left side of the instrument panel.
	Radio does not operate.	Locate and repair the open in the black wire between the splice and ground at the data link connector.
6. Connect the test lamp from the tan wire at the headlamp dimmer switch to ground.	Test lamp lights.	Locate and repair the open in the tan wire from the headlamp dimmer switch connector to the headlamp connector(s).
	Test lamp does not light.	Replace the headlamp dimmer switch.

HIGH BEAM LAMP(S) DO NOT OPERATE

TEST	RESULT	ACTION
1. Place the headlamp switch in the ON position and the headlamp dimmer switch in the high beam position. Connect a test lamp from the light green wire at the inoperative lamp(s) to ground.	Test lamp lights.	Go to step 2.
	Test lamp does not light.	Go to step 6.
2. Connect the test lamp from the light green wire to the black wire at the right headlamp connector or to the dark blue/white wire at the left headlamp connector.	Test lamp lights.	Replace the headlamp(s).
	Test lamp does not light.	Locate and repair the open in the black wire from the right headlamp connector to ground. Go to step 3 for the left headlamp.

3. Connect a test lamp from the dark blue/white wire at the DRL relay connector to ground.	Test lamp lights.	Locate and repair the open in the dark blue/white wire between the relay connector and the left headlamp connector.
	Test lamp does not light.	Go to step 4.
4. Connect the test lamp from the black wire at the relay connector to ground.	Test lamp lights.	Replace the DRL relay.
	Test lamp does not light.	Go to step 5.
5. Turn on the radio.	Radio operates.	Locate and repair the open in the black wire between the relay connector and the splice under the left side of the instrument panel.
	Radio does not operate.	Locate and repair the open in the black wire between the splice and ground at the data link connector.
6. Connect the test lamp from the light green wire at the headlamp dimmer switch connector to ground.	Test lamp lights.	Locate and repair the open in the light green wire from the headlamp dimmer switch connector to the headlamp connector(s).
	Test lamp does not light.	Replace the headlamp dimmer switch.

T2890

DAYTIME RUNNING LIGHTS STAY ON

TEST	RESULT	ACTION
Remove the DRL circuit board from the module case. Place the ignition switch in RUN and the headlamp switch ON. Connect a voltmeter to the yellow wire at the module case to ground.	Battery voltage.	Replace the DRL module circuit board.
	No voltage.	Locate and repair the open in the yellow wire from the DRL module to the headlamp switch.

T2354

DIAGNOSIS OF THE REAR EXTERIOR LAMPS

PRELIMINARY CHECKS:

- Rear lamp systems (taillamps, clearance lamps, endgate lamps, and license plate lamps) all receive voltage from the same brown wire circuit and share the same ground terminal located at the left rear side member or at the left side of the platform hitch. If only one system is not working, locate and repair the open in the wiring and/or bulbs that pertain to that system.
- If none of the rear lamp systems work, check the PARK LP fuse.

STOPLAMPS DO NOT OPERATE

TEST	RESULT	ACTION
1. Connect a test lamp from the orange wire at the stoplamp switch to ground.	Test lamp lights.	Go to step 3.
	Test lamp does not light.	Check the condition of the STOP-HAZ fuse. If the fuse is OK, go to step 2.
2. Turn on the hazard flashers.	Hazard flashers operate.	Locate and repair the open in the orange wire between the splice and the stoplamp switch.
	Hazard flashers do not operate.	Locate and repair the open in the orange wire between the fuse block and the splice.
3. Connect the test lamp from the white wire at the stoplamp switch connector to ground. Depress the brake pedal.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Replace the stoplamp switch.

DIAGNOSIS OF THE REAR EXTERIOR LAMPS

4. Connect the test lamp from the white wire at the turn signal switch connector to ground. Depress the brake pedal.	Test lamp lights.	Go to step 5.
	Test lamp does not light.	Locate and repair the open in the white wire between the stoplamp switch connector and turn signal switch connector.
5. Connect the test lamp from the yellow or dark green wire at the turn signal switch connector to ground. Depress the brake pedal.	Test lamp lights.	Verify the condition of the bulkhead connector and the rear lamp connector at the left rear crossmember.
	Test lamp does not light.	Replace the turn signal switch.

STOPLAMPS DO NOT OPERATE ON ONE SIDE

TEST	RESULT	ACTION
1. Connect a test lamp from the yellow or dark green wire at the affected stoplamp connector to ground. Depress the brake pedal.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Go to step 2.
2. Connect the test lamp from the yellow or dark green wire (depending on the side with the failure) at the connector at the left rear crossmember to ground. Depress the brake pedal.	Test lamp lights.	Locate and repair the open in the yellow or dark green wire between the connector and the affected stoplamp.
	Test lamp does not light.	Go to step 3.
3. Connect the test lamp from the yellow or dark green wire (depending on the side with the failure) at the connector at the bulkhead to ground. Depress the brake pedal.	Test lamp lights.	Locate and repair the open in the yellow or dark green wire between the connector and the connector at the left rear crossmember.
	Test lamp does not light.	Locate and repair the open in the yellow or dark green wire between the connector at the bulkhead and the turn signal switch connector. If no open is found, replace the turn signal switch.
4. Connect a test lamp from the black wire at the affected stoplamp to ground.	Test lamp lights.	Replace the stoplamp.
	Test lamp does not light.	Locate and repair the open in the black wire between the stoplamp and ground.

REAR LAMP SYSTEMS DO NOT OPERATE

TEST	RESULT	ACTION
1. Place the headlamp switch in PARK. Observe the front park and marker lamps.	Front park and marker lamps operate.	Go to step 3.
	Front park and marker lamps to not operate.	Check the condition of the PARK LP fuse. If the fuse is OK, go to step 2.
2. Push the horn button.	Horn sounds.	Locate and repair the open in the orange wire between the splice under the left side of the instrument panel and the headlamp switch connector. If no open is found, replace the headlamp switch.
	Horn does not sound.	Locate and repair the open in the orange wire between the fuse block and the splice.
3. Connect the test lamp from the brown wire at the left tail, stop, turn and backup lamp connector to ground.	Test lamp lights.	Locate and repair the open in the black wire between the splice at the left rear crossmember and ground. Check the condition of the ground.
	Test lamp does not light.	Go to step 4.

DIAGNOSIS OF THE REAR EXTERIOR LAMPS

4. Connect the test lamp from the brown wire at the connector and the left rear crossmember to ground.	Test lamp lights.	Locate and repair the open in the brown wire between the connector and the splice under the left side of the instrument panel.
	Test lamp does not light.	Go to step 5.
5. Connect the test lamp from the brown wire at the bulkhead connector to ground.	Test lamp lights.	Locate and repair the open in the brown wire between the bulkhead connector and the connector at the left rear crossmember.
	Test lamp does not light.	Locate and repair the open in the brown wire between the splice under the left side of the I/P and the bulkhead connector.

T2896

DIAGNOSIS OF THE ROOF MARKER LAMPS

The splices referred to in this chart are located in the wiring harness above the bulkhead connector under the left side of the instrument panel.

ROOF MARKER LAMPS DO NOT OPERATE

TEST	RESULT	ACTION
1. Turn the parking lamps on. Connect a test lamp from the orange wire at the headlamp switch to ground.	Test lamp lights.	Go to step 3.
	Test lamp does not light.	Go to step 2.
2. Push the horn button.	Horn sounds.	Locate and repair the open in the orange wire between the headlamp switch and the splice.
	Horn does not sound.	Check the condition of the PARK LP fuse. If the fuse is good, locate and repair the open in the orange wire from the fuse block to the splice.
3. Connect the test lamp from the brown wire at the headlamp switch to ground.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Replace the headlamp switch.
4. Connect the test lamp at the white wire at the convenience center to ground.	Test lamp lights.	Go to step 6.
	Test lamp does not light.	Go to step 5.
5. Check the condition of the parking lamps.	Parking lamps operate.	Locate and repair the open in the brown wire between the splice and convenience center.
	Parking lamps do not operate.	Locate and repair the open in the brown wire from the splice to the headlamp switch.
6. Connect a test lamp from the black wire at the convenience center to ground.	Test lamp lights.	Locate and repair the open in the white wire or the black wire in the roof marker lamps harness.
	Test lamp does not light.	Go to step 7.
7. Turn on the radio.	Radio operates.	Locate and repair the open in the black wire between the convenience center and splice.
	Radio does not operate.	Locate and repair the open in the black wire between the splice and ground.

T2895

DIAGNOSIS OF THE TURN SIGNAL SYSTEM

If the turn signals do not work, turn on the hazard system. If all the lamps operate, check the TURN/BU fuse and replace it if necessary. If the turn signals still don't work, but the hazard system does, replace the turn signal flasher unit.

TURN SIGNALS DO NOT OPERATE ON ONE SIDE (FRONT)

TEST	RESULT	ACTION
1. Turn the hazard flasher ON. Observe the lamps on the side of the turn signals that do not work.	Lamps flash.	Check for improper bulb. Replace if necessary.
	Lamps do not come on.	Go to step 2.
2. Turn the hazard flasher OFF. Turn the ignition switch to RUN and the turn signals to the side that does not work. Connect the test lamp from the light blue wire (left) or dark blue wire (right) at the turn signal switch connector to ground.	Test lamp lights.	Go to step 3.
	Test lamp does not light.	Replace the turn signal switch.
3. Connect the test lamp from the light blue wire (left) or dark blue wire (right) at the park lamp connector to ground.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Locate and repair the open in either the light blue or dark blue wires.
4. Connect the test lamp from the light blue or dark blue wire to the black wire at the park lamp connector.	Test lamp lights.	Check the condition of the bulb sockets.
	Test lamp does not light.	Locate and repair the open in the black wire.

TURN SIGNALS DO NOT OPERATE ON ONE SIDE (REAR)

TEST	RESULT	ACTION
1. Turn the hazard flasher ON. Observe the lamps on the side of the turn signals that do not work.	Lamps flash.	Check for improper bulb. Replace if necessary.
	Lamps do not come on.	Go to step 2.
2. Turn the hazard flasher OFF. Turn the ignition switch to RUN and the turn signal to the side that does not work. Connect the test lamp from the yellow wire (left) or dark green wire (right) at the turn signal switch connector to ground.	Test lamp lights.	Go to step 3.
	Test lamp does not light.	Replace the turn signal switch.
3. Connect the test lamp from the yellow wire (left) or dark green wire (right) at the taillamp connector to ground.	Test lamp lights.	Go to step 4.
	Test lamp does not light.	Locate and repair the open in either the yellow or dark green wires.
4. Connect the test lamp from the black wire at the taillamp connector.	Test lamp lights.	Check condition of the bulb sockets.
	Test lamp does not light.	Locate and repair the open in the black wire.

T2683

ON-VEHICLE SERVICE OF EXTERIOR LIGHTING

CARGO/STOPLAMP REPLACEMENT

PICKUP AND CAB/CHASSIS MODELS



Remove or Disconnect (Figure 18)

- Make sure the headlamp switch is off.

1. Lens screws and lens.
2. Bulb.
3. Lamp assembly screws.
4. Lamp assembly from the roof.
5. Wiring harness from the lamp assembly.
6. Gasket from the roof.

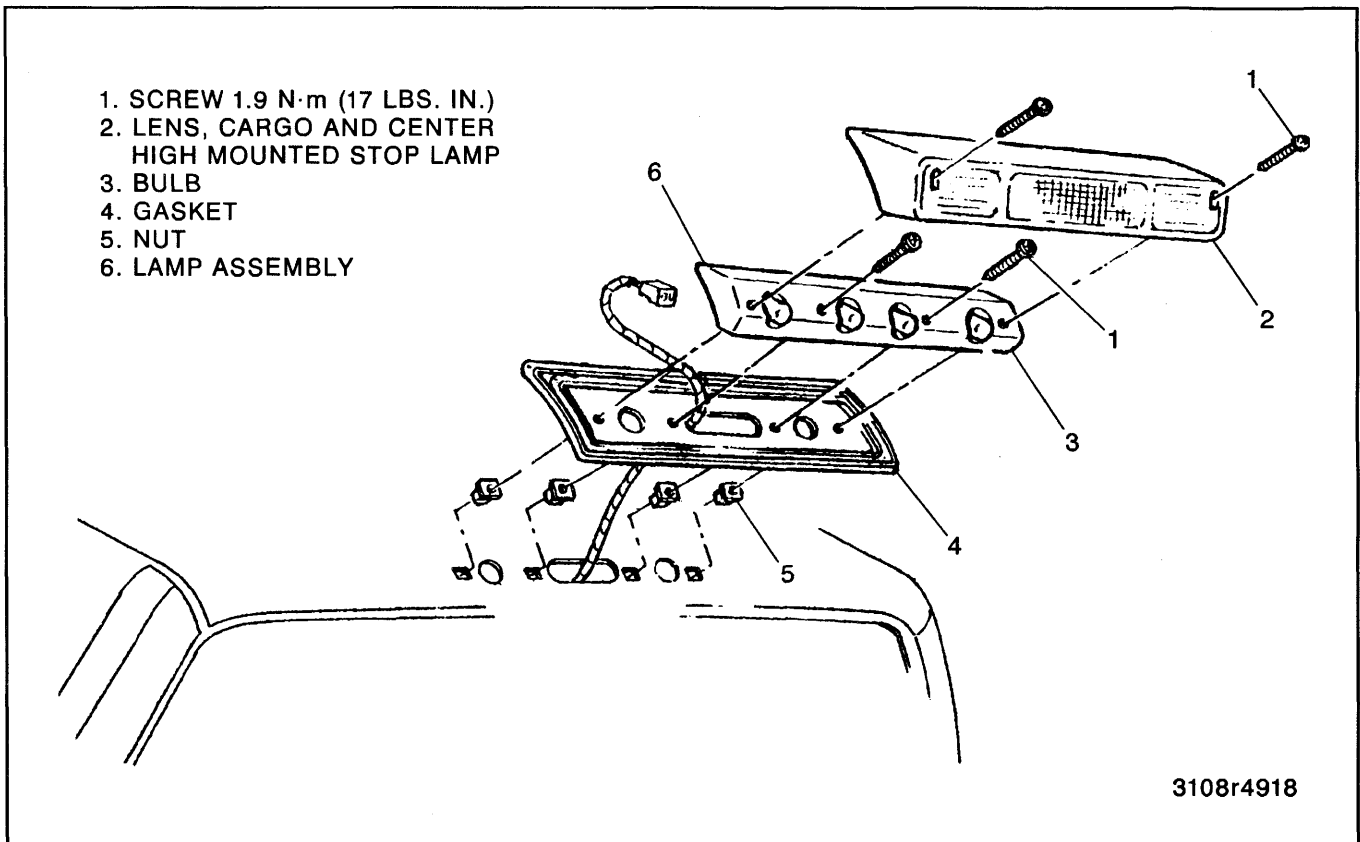


Figure 18—Cargo/Stoplamp Components (Pickup and Cab/Chassis Models)

Install or Connect (Figure 18)

1. Gasket to the roof.
2. Wiring harness to the lamp assembly.
3. Lamp assembly to the roof.
4. Lamp assembly screws.
5. Bulb.
6. Lens screws and lens.

**CENTER HIGH-MOUNTED
STOPLAMP REPLACEMENT**

SUBURBAN AND UTILITY MODELS

Remove or Disconnect (Figure 19)

- Make sure the headlamp switch is OFF.
1. Rear dome lamp. Refer to "Dome Lamp Replacement."
 2. Electrical connector from the dome lamp harness.
 3. CHMSL retaining screws.
 4. CHMSL from the vehicle.

Install or Connect (Figure 19)

1. CHMSL lamp wire through hole in the roof panel and connect it to the dome lamp harness.

2. CHMSL to the vehicle with screws.

Tighten

- CHMSL retaining screws to 1.9 N.m (17 lbs. in.).
3. Rear dome lamp. Refer to "Dome Lamp Replacement."

**COMPOSITE HEADLAMP
BULB REPLACEMENT**

Remove or Disconnect (Figures 20 and 21)

- Make sure the headlamp switch is off.
1. Grille. Refer to SECTION 2B.
 2. Bulbs from the headlamp capsules by reaching in from the engine compartment and twisting to the left.

NOTICE: Refer to "Notice" on page 8B-1.

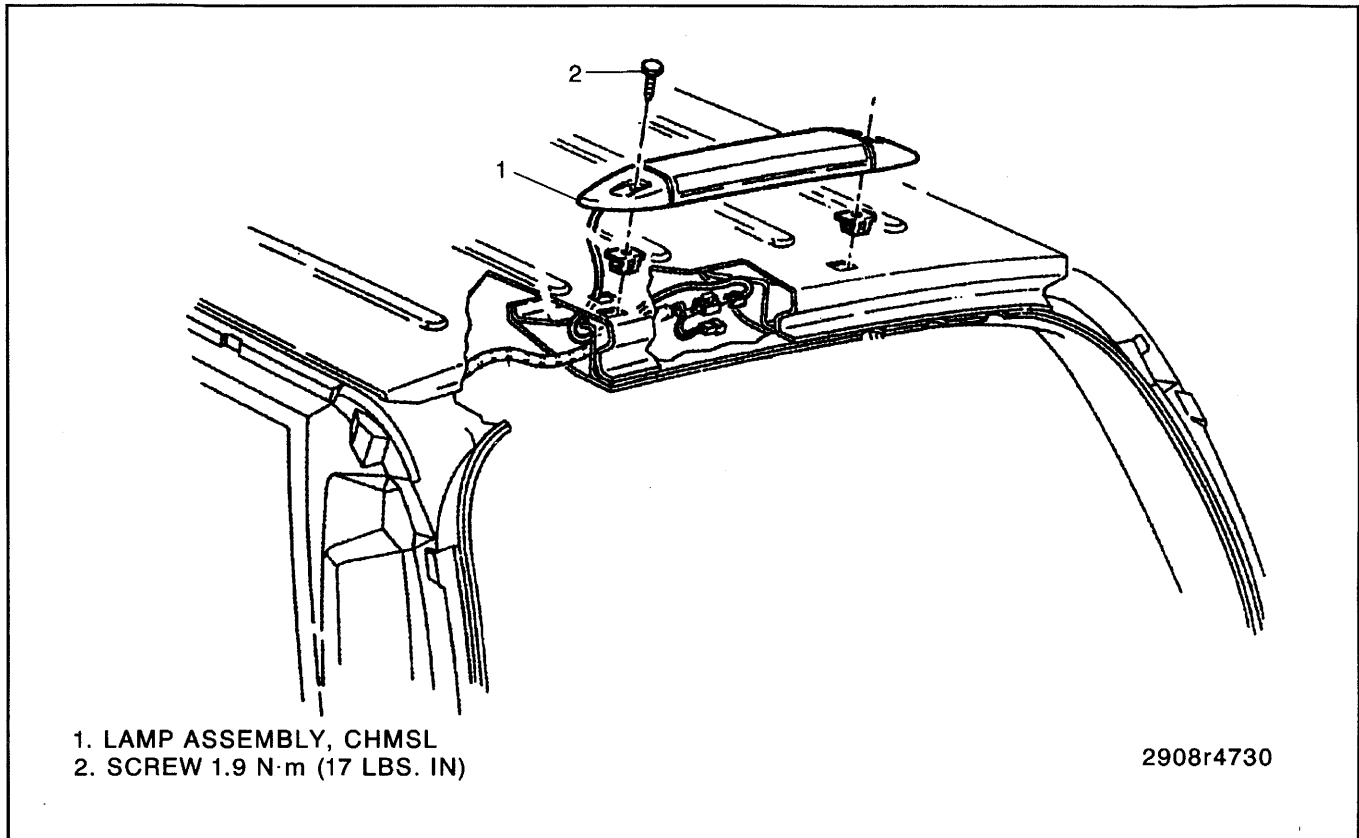


Figure 19—CHMSL Replacement (Utility)

CAUTION: Halogen bulbs contain a gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing it. Leave the switch off until change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Do not drop or scratch the bulb. Keep moisture away.
- Place the used bulb in the new bulb's carton and dispose of it properly.

3. Two long screws from the top of the radiator support (figure 20).

- Pull the headlamp assembly forward.

4. Electrical connector from the burned out bulb assembly.

→← Install or Connect (Figures 20 and 21)

NOTICE: Avoid touching the bulb or letting it come in contact with anything damp. Oil from your skin or moisture on the bulb can cause the bulb to explode when it is turned on. If either comes in contact with the bulb, clean it with alcohol or a suitable degreaser and wipe the bulb dry.

1. New bulb assembly into the headlamp assembly and twist it to the right. It should seat with the connector facing downward.

- Be sure to replace a high beam bulb assembly with another high beam bulb assembly and a low beam bulb assembly with another low beam bulb assembly. The low beam bulb has a gray tip and a yellow gasket at its base. The high beam bulb has a red gasket.

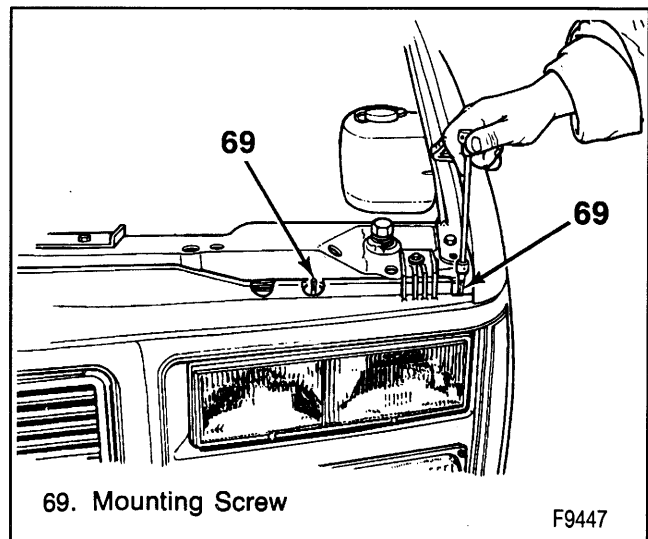


Figure 20—Composite Headlamp Removal

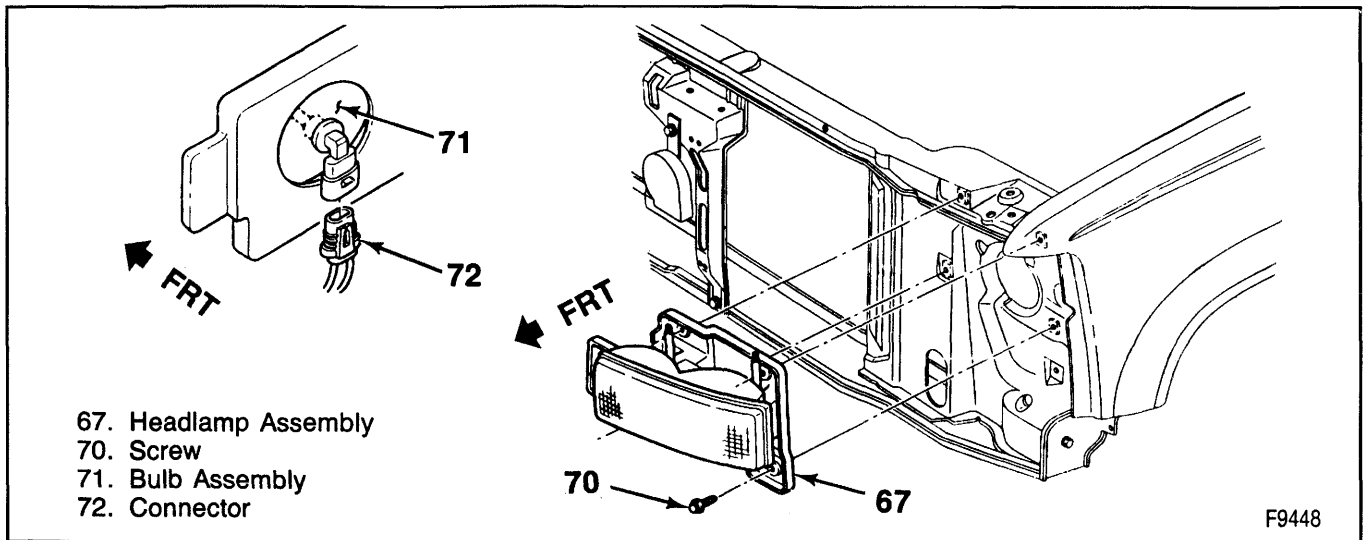


Figure 21—Composite Headlamp Assembly

2. Electrical connector to the bulb assembly.
3. Headlamp assembly.
4. Two long screws through the top of the radiator support and tighten.
5. Grille. Refer to SECTION 2B.

COMPOSITE HEADLAMP ADJUSTMENT

Horizontal and vertical aiming of each headlamp assembly is done by two adjusting screws. The screws are located within the radiator support, and are not easily seen. Two holes in the radiator support for each headlamp assembly provide access to the recessed brass adjusting screws (figures 22 and 23). The screws can be turned using a T15 torx head bit.

Adjust the headlamps to the specifications required by state and/or local authorities.

There are three methods for aiming the headlamps.

VISUAL HEADLAMP AIMING PROCEDURE (PREFERRED)

All equipment for testing headlamps must comply with the SAE Recommended Practice for Headlamp Inspection Equipment.

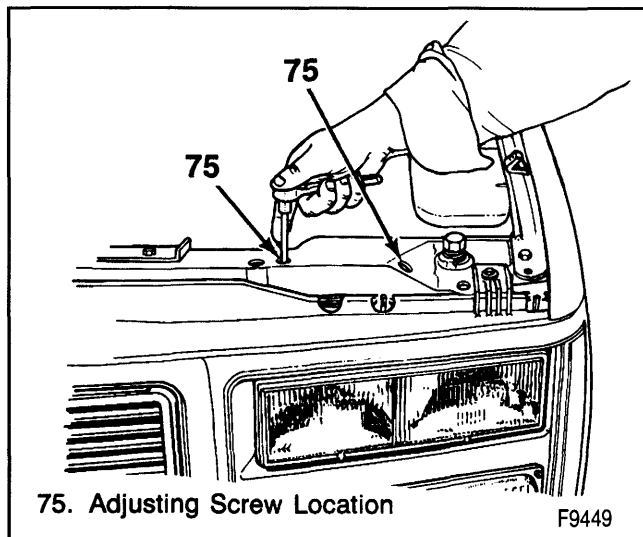


Figure 22—Adjusting the Headlamps

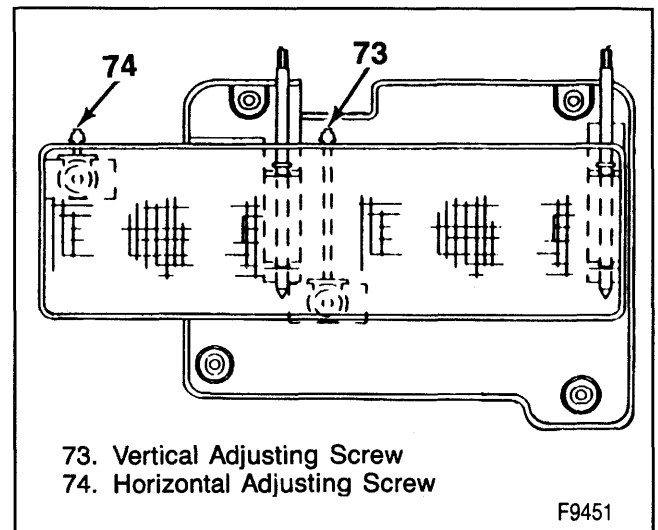


Figure 23—Composite Headlamps Adjusting Screws

If a headlamp testing machine is used, it should give results equivalent to those obtained using the screen procedure as shown in figure 24. It should be in good repair and properly adjusted, and should be used in accordance with the manufacturer's instructions. The machine using a photoelectric cell or cells to determine aim should also include a visual screen upon which the beam pattern can be projected proportional to its appearance and aim on a screen at 7.62 m (25 ft). The screen should be plainly visible to the technician who is adjusting the headlamps, and should have horizontal and vertical reference lines to permit visual appraisal of the headlamp beam.

HEADLAMP AIMING BY THE SCREEN METHOD

Location

The area should be darkened and large enough to allow for the vehicle and an additional 7.62 m (25 ft.) measured from the face of the headlamps to the front of the screen. The floor on which the vehicle rests must be flat with the bottom of the screen. If the floor is not level, compensate.

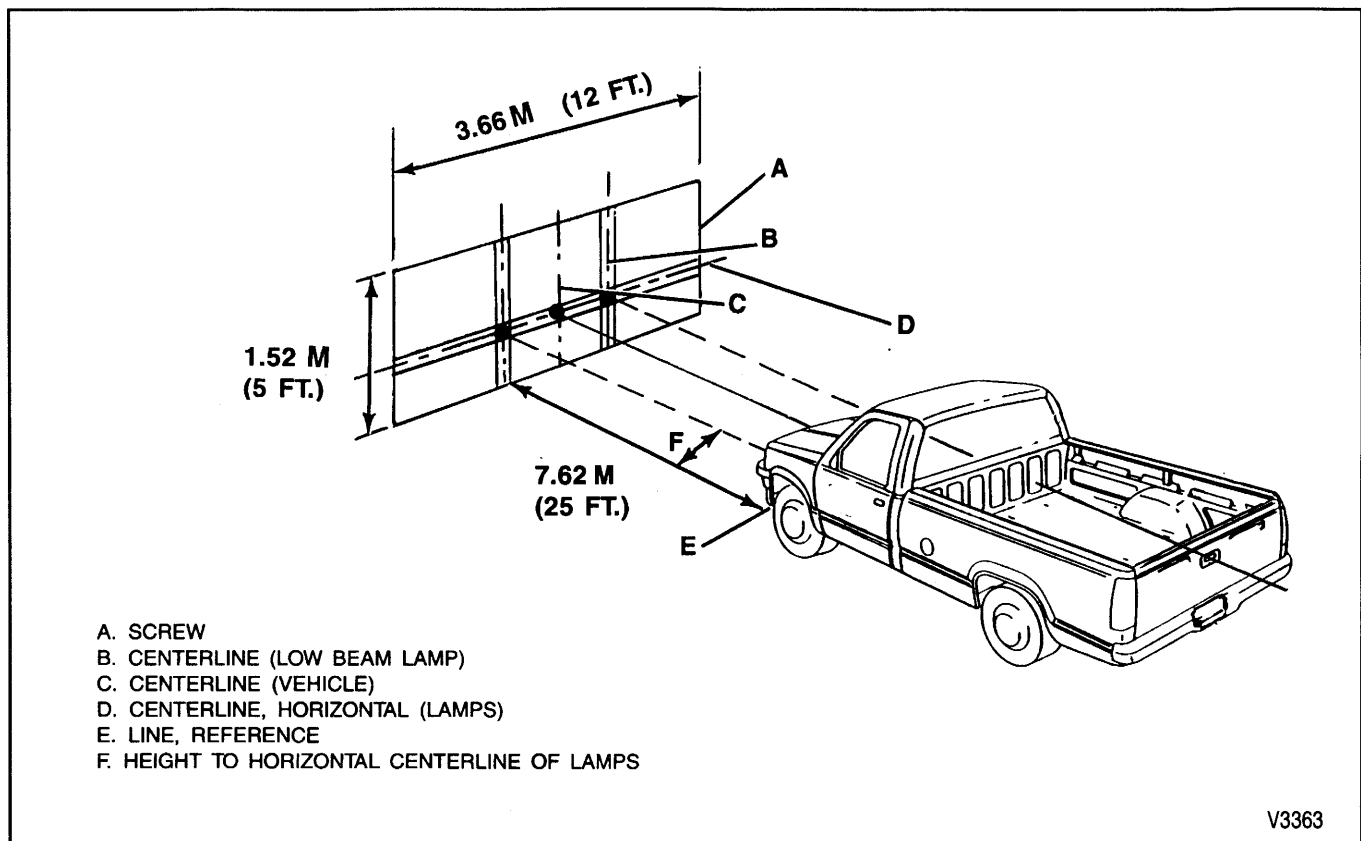


Figure 24—Visual Headlamp Inspection and Adjustment

Aiming Screen

If a screen is used, it should be at least 1.52 m (5 ft.) high by 3.66 m (12 ft.) wide with a matte white surface well shaded from extraneous light, and properly adjusted to the floor on which the vehicle stands. The screen should be moveable so that it can be aligned parallel with the rear axle of the vehicle. It should be positioned so that a horizontal line drawn perpendicular to the centerline of the screen will pass an equal distance midway between the two headlamps (figure 24).

The screen should be provided with a vertical centerline, two laterally adjustable vertical tapes, and one vertically adjustable horizontal tape.

If a regular commercial aiming screen is not available, the screen may consist of a wall having a clear uninterrupted area at least 1.83 m (6 ft.) high by 3.66 m (12 ft.) wide. The surface should be finished with a washable no-gloss white paint.

After the aiming screen has been set up and located, paint or tape a reference line on the floor 7.62 m (25 ft.) from the screen. The vehicle should be parked with the front of the headlamps directly over this reference line.

Headlamp Aiming Procedure

1. Park the vehicle square with the screen and with the headlamps directly over the reference line.
2. Make sure all components are in place, if other work has been done on the vehicle.
3. Make sure the vehicle is on a level surface.
4. Stop all other work on the vehicle.
5. Make sure the vehicle has one-half tank of fuel or less.
6. Close the vehicle's doors.

7. Rock the vehicle sideways.

8. Line up the centerline of the vehicle with the centerline of the aiming screen. This can be done by marking the vertical center of the rear and front windows with tape. Use these lines as "sights" to line up the centerline of the vehicle and screen.

9. Adjust the vertical tapes on the screen to match the vertical centerline of each low beam lamp. (Measure the distance from the centerline of the vehicle to the centerline of a low beam lamp).

10. Adjust the horizontal tapes on the screen to match the horizontal centerline of each low beam headlamp. (Measure the height from floor to the center of a low beam).

11. Turn on the low beam lamps. Observe the left and top edges of the high intensity zone on the screen. Adjust the headlamps so that:

- A. The top edge of the center of intensity on the screen for the low beam is less than 101.6 mm (4 in.) above or below the cross section of the headlamp centerlines.

- B. The left edge of the center of intensity on the screen for the low beam is less than 101.6 mm (4 in.) to the left or right of the cross section of the headlamp centerlines.

HEADLAMP AIMING ALTERNATIVE PROCEDURE

Tool Required:

J 25300-B Headlamp Aimer

Prepare the vehicle.

1. Make sure all components are in place, if other work has been done on the vehicle.
2. Make sure the vehicle is on a level surface.

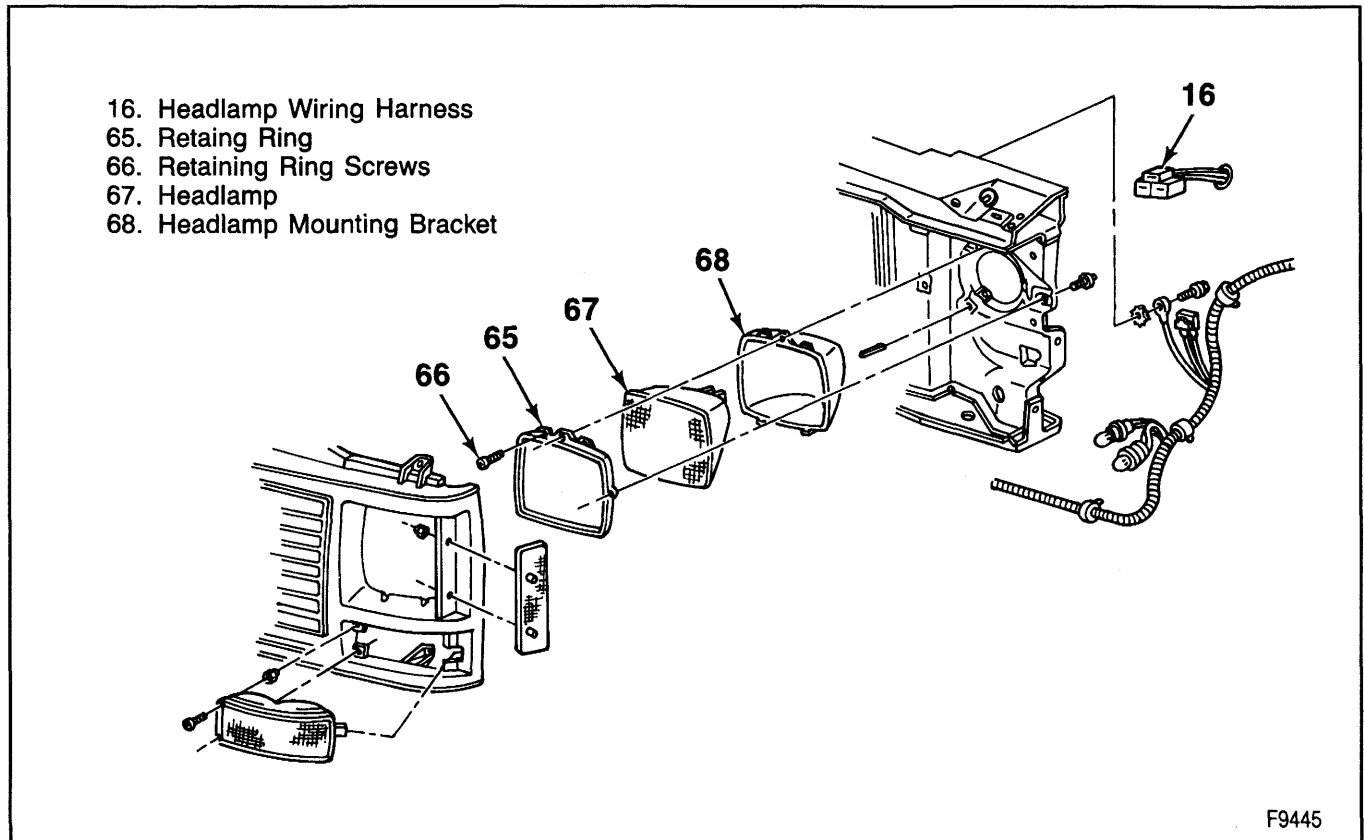


Figure 25—Dual Headlamp Components

3. Stop all other work on the vehicle.
4. Make sure the vehicle has one-half tank of fuel or less.
5. Close the doors.
6. Rock the vehicle sideways.

Using Headlamp Aimer J 25300-B, adjust the headlamps to the specifications required by state and/or local authorities. Instructions for tool use accompany the tool. This kit contains special adapters for use with composite lenses.

If an older kit without the special adapters is already on hand, the adapters can be purchased separately. Use J 25300-203, Composite Headlight Aimer Adapter (Small Pad Pattern). The adapter set contains a set of blue square adapters, vacuum cup extenders, and complete instructions.

SEALED BEAM HEADLAMP REPLACEMENT

↔ Remove or Disconnect (Figure 25)

- Make sure the headlamp switch is off.
1. Retaining ring screws from the retaining ring.
 2. Retaining ring from the headlamp.
 3. Headlamp from the headlamp mounting bracket.
 4. Electrical connector from the headlamp.

→→ Install or Connect (Figure 25)

1. Electrical connector to the headlamp.

2. Headlamp to the headlamp mounting bracket.
3. Retaining ring to the headlamp.
4. Retaining ring screws to the retaining ring.

SEALED BEAM HEADLAMP ADJUSTMENT

Tool Required:

J 25300-B Headlamp Aimer

Horizontal and vertical aiming of each headlamp is done by two adjusting screws which move the mounting bracket against the tension of the coil spring (figure 26). These screws are located in the headlamp bezel area on sealed beam headlamp models (one above and one to the side of the headlamp).

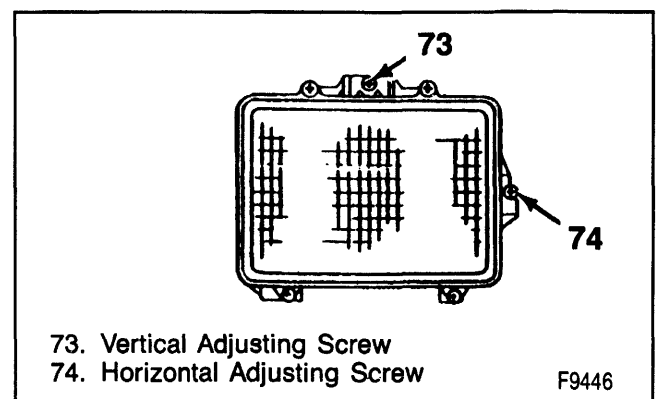


Figure 26—Headlight Aiming Screws (Dual Headlamps)

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The adjusting screw directly above the headlamp is used to adjust the horizontal position while the screw to the side is used to adjust the vertical position of the headlamp.

Using Headlamp Aimer J 25300-B, adjust the headlamps to the specifications required by state and/or local authorities. Instructions for tool use accompany the tool.

The headlamps can also be adjusted using the screen method described earlier for composite headlamps. Follow the same directions and observe the same tolerances for the aim of the beam.

ENDGATE LAMP REPLACEMENT

↔ Remove or Disconnect (Figure 27)

The lens, lamp, and base must be replaced as one assembly.

- Make sure the headlamp switch is off.

1. Lens.
2. Two screws.

3. Lamp assembly.

↔ Install or Connect (Figure 27)

1. Lamp assembly to the endgate.
2. Two screws.
3. Lens.

FOG LAMP ADJUSTMENT

The fog lamps are bracket mounted to the air dam and bumper (figure 28).

Before checking the aim of the fog lamps, prepare the vehicle.

1. Make sure all components are in place, if other work has been done on the vehicle.
2. Make sure the vehicle is on a level surface.
3. Stop all other work on the vehicle.
4. Make sure the vehicle has one-half tank of fuel or less.
5. Close the doors.
6. Rock the vehicle sideways.
7. Make sure the vehicle has no load other than the driver.

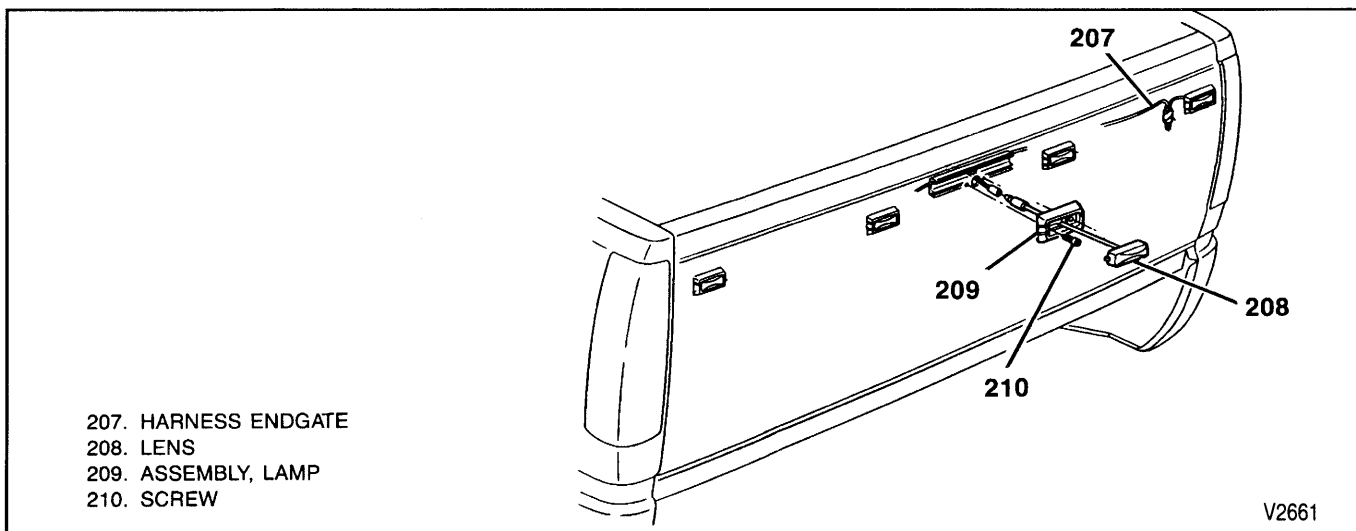


Figure 27—Endgate Identification Lamps

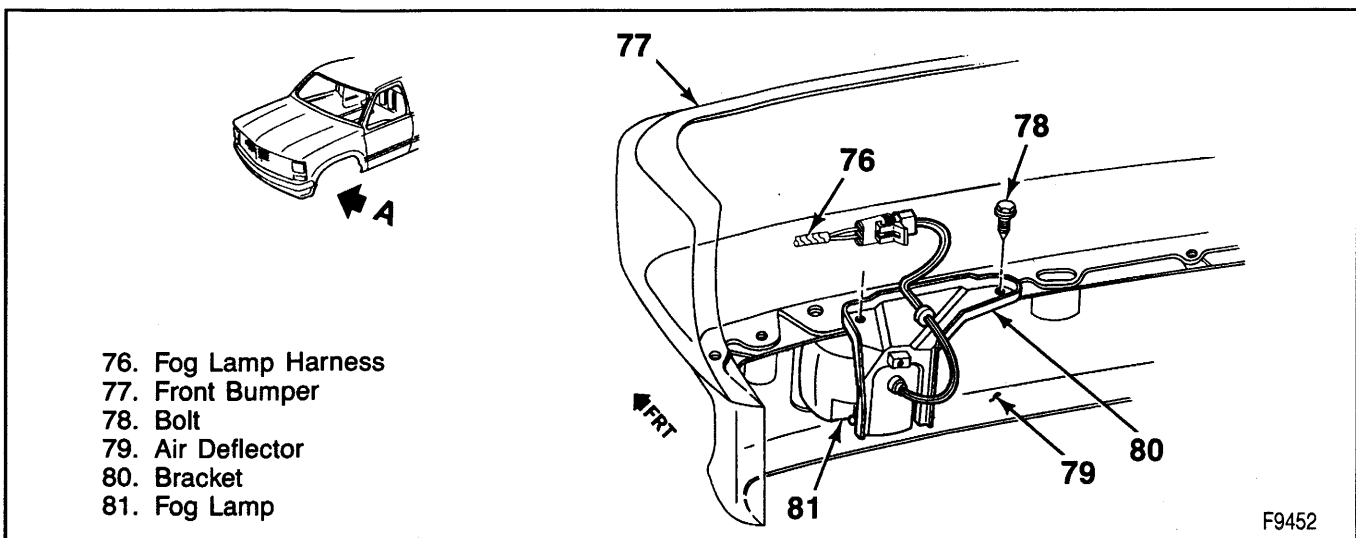


Figure 28—Fog Lamps

Place a screen 760 mm (2.5 ft.) in front of the vehicle. Draw a horizontal line at the same height as the centerline of the lamps (figure 29). Turn on the fog lamps. The top edge of the high intensity zone should be 5 to 20 mm (0.2 to 0.8 inches) below the centerline of the lamps.

The fog lamps can be adjusted up and down by turning the adjusting screw above the lens on the lamp assembly. The lamps cannot be adjusted horizontally.

The fog lamps can also be adjusted using the screen method described in "Composite Headlamp Adjustment" earlier in this section. The vehicle should be parked 7.62 m (25 ft.) in front of the screen. Using tape, make a horizontal line on the screen at the same height as the centerline of the lamps. Then turn on the fog lamps. The top edge of the high intensity zone should be 101.6 mm (4 inches) below the horizontal centerline of the fog lamps.

FOG LAMP BULB REPLACEMENT



Remove or Disconnect

- Make sure the headlamp switch and fog lamp switch are off.
- 1. Two screws and the lens from the front of the lamp assembly.

CAUTION: Halogen bulbs contain a gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing it. Leave the switch off until change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Do not drop or scratch the bulb. Keep moisture away.
- Place the used bulb in the new bulb's carton and dispose of it properly.

2. Bulb by twisting it to the left.



Install or Connect

NOTICE: Avoid touching the bulb or letting it come in contact with anything damp. Oil from your skin or moisture on the bulb can cause the bulb to explode when it is turned on. If either comes in contact with the bulb, clean it with alcohol or a suitable degreaser and wipe the bulb dry.

1. Bulb into the lamp assembly and twist it to the right.
2. Lens and two screws.

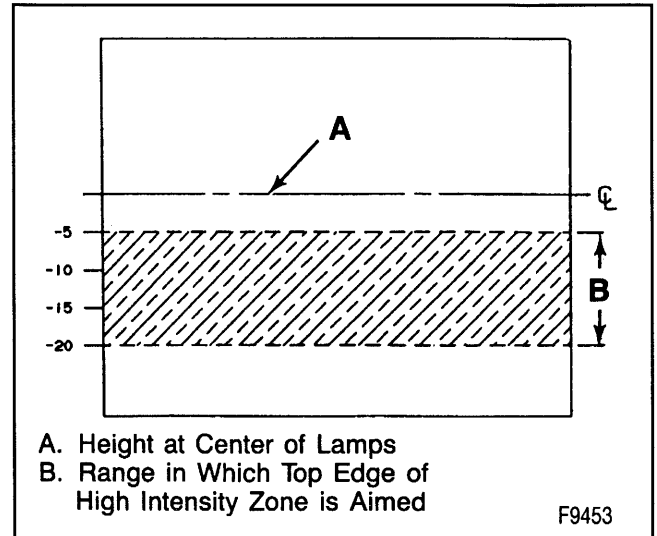


Figure 29—Fog Lamp Aiming Zone

FRONT PARKING LAMP REPLACEMENT

There are two bulbs in the parking lamp assembly and one bulb in the front side marker. All three turn on together as turn signals and parking lights.



Remove or Disconnect (Figure 30)

- Make sure the headlamp switch is off.
- 1. Screws.
- 2. Parking lamp assembly.
- 3. Electrical connector.
- 4. Bulbs from the assembly.



Install or Connect (Figure 30)

1. Bulbs to the parking lamp assembly.
2. Lamp assembly.
3. Parking lamp electrical connector.
4. Screws.

FRONT SIDE MARKER AND REFLECTOR REPLACEMENT



Remove or Disconnect (Figure 30)

- Make sure the headlamp switch is off.
- 1. Grille. Refer to "Grille Replacement" in SECTION 2B.
- 2. Nuts.
- 3. Side marker and/or reflector lens.
- 4. Bulb from the electrical connector.



Install or Connect (Figure 30)

1. Bulb to the electrical connector.
2. Side marker and/or reflector lens.
3. Nuts to the side marker.
4. Grille.

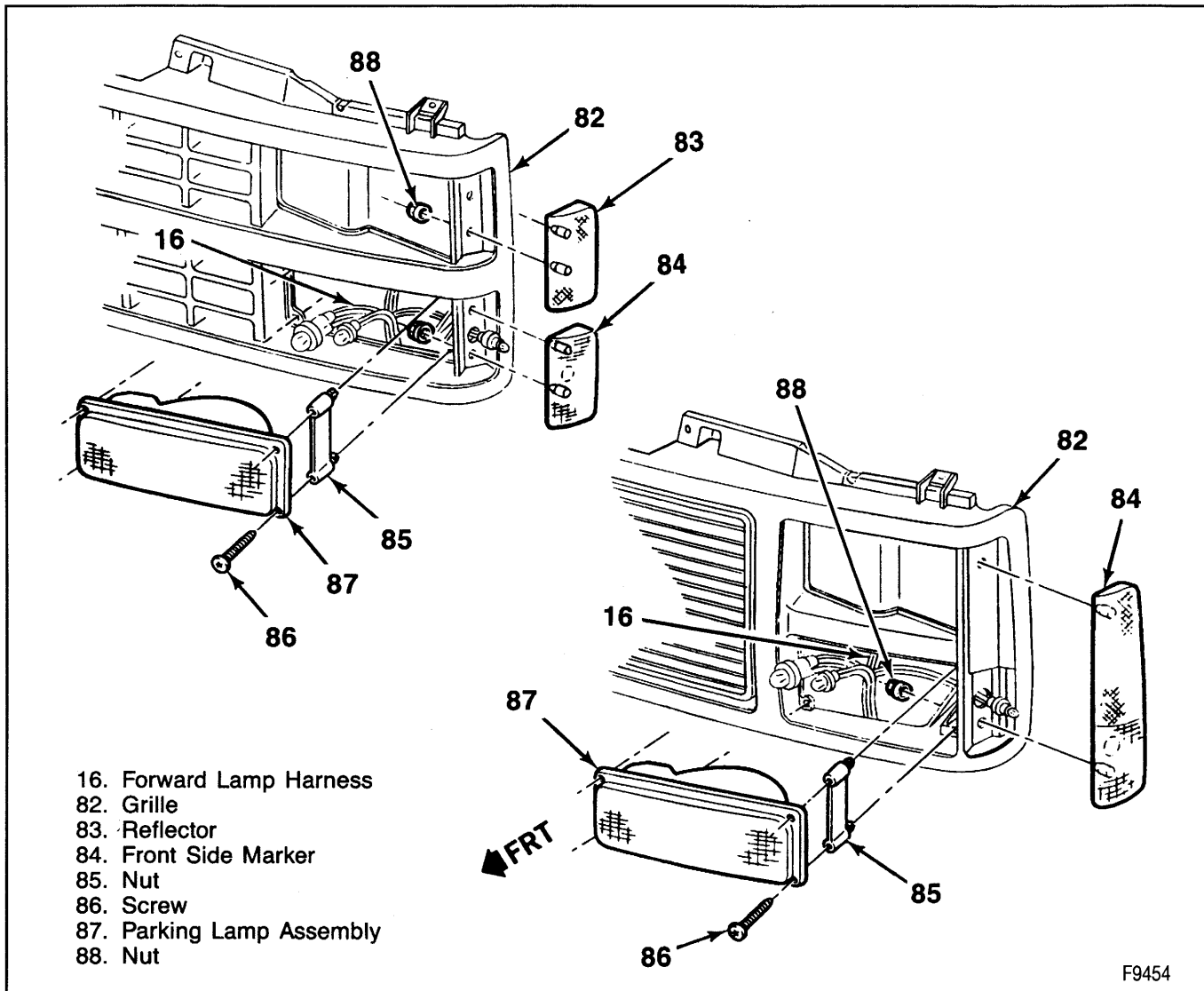


Figure 30—Parking Lamp and Reflector Components

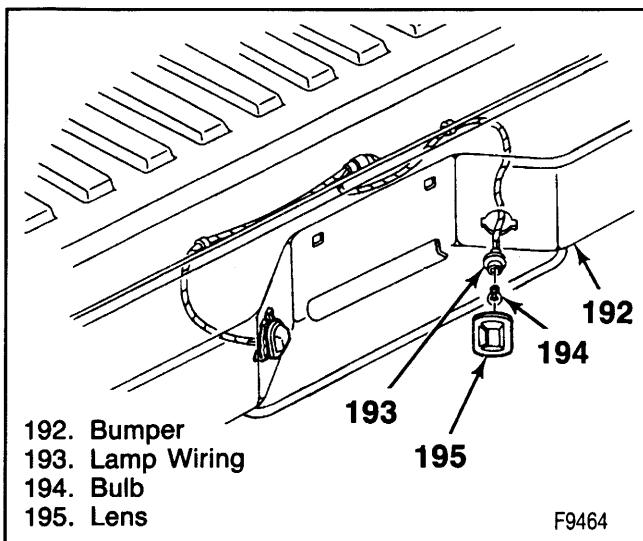


Figure 31—License Plate Lamp - Models with a Step Bumper

LICENSE LAMP REPLACEMENT

↔ Remove or Disconnect (Figures 31 through 35)

- Make sure the headlamp switch is off.

1. Lens from the lamp assembly or lamp from the back of the lens assembly.
2. Bulb.

→ Install or Connect (Figures 31 through 35)

1. Bulb.
2. Lens to the lamp assembly or bulb and wiring to the back of the lens assembly.

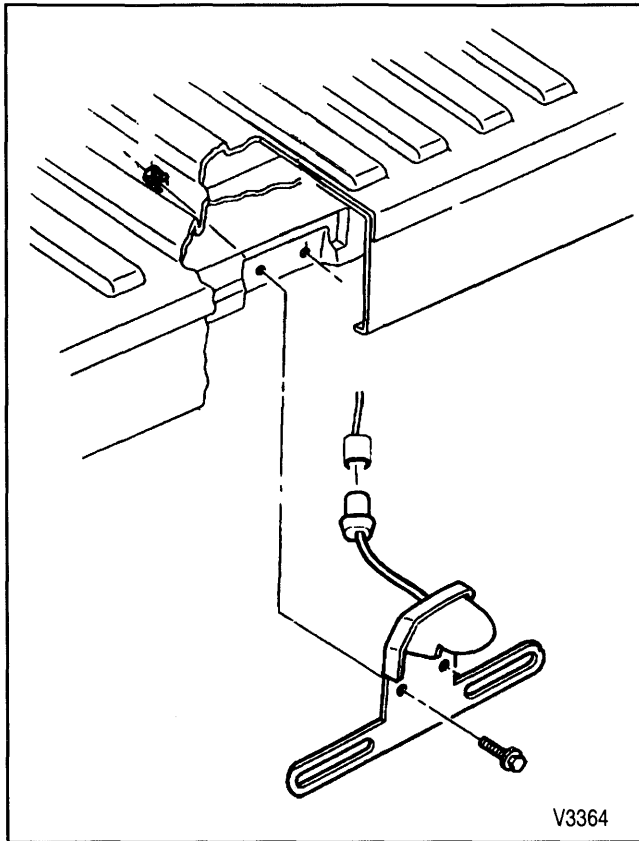


Figure 32—License Plate Lamp - Fleetside Pickup without a Step Bumper

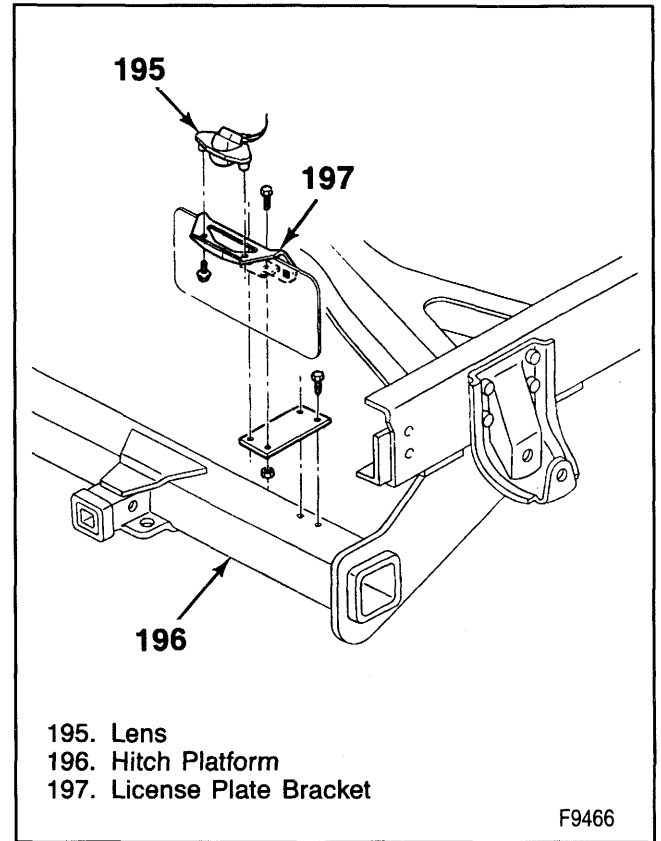


Figure 34—License Plate Lamp - Cab/Chassis with Hitch Platform

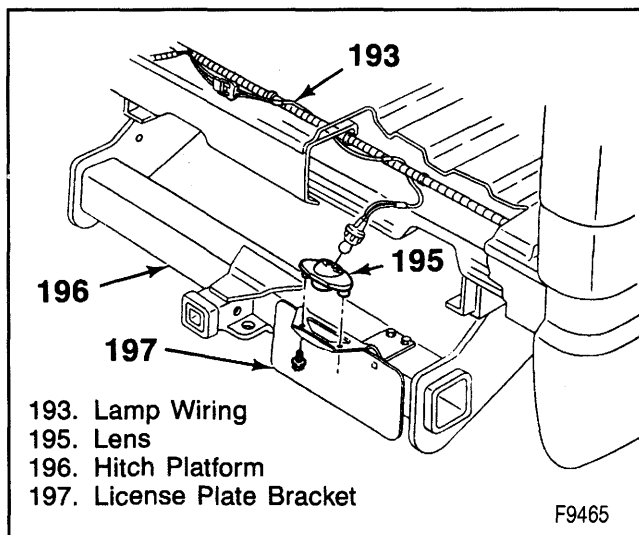


Figure 33—License Plate Lamp - Pickup with Hitch Platform

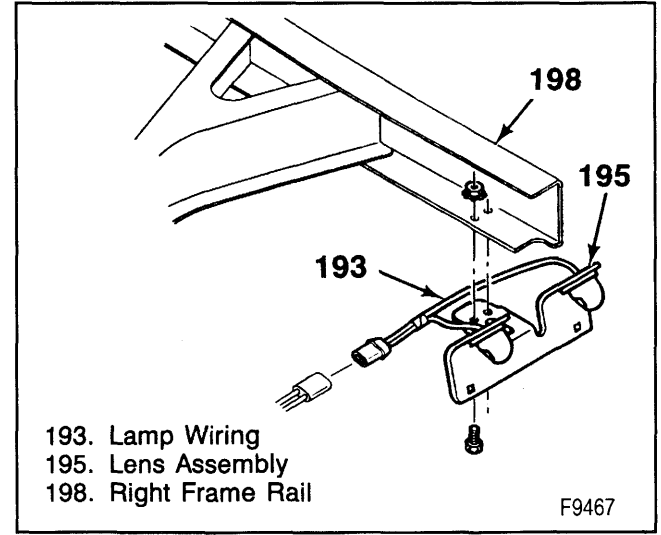


Figure 35—License Plate Lamp - Pickup without a Bumper

REAR FENDER MARKER LAMP REPLACEMENT

↔ Remove or Disconnect (Figure 36)

- Make sure the headlamp switch is off.
- 1. Lamp assembly screws.
- 2. Lamp assembly from the fender.

↔ Install or Connect (Figure 36)

1. Bulb to the socket.
2. Electrical connector and bulb to the lamp.
3. Lamp assembly to the fender.
4. Lamp assembly screws.

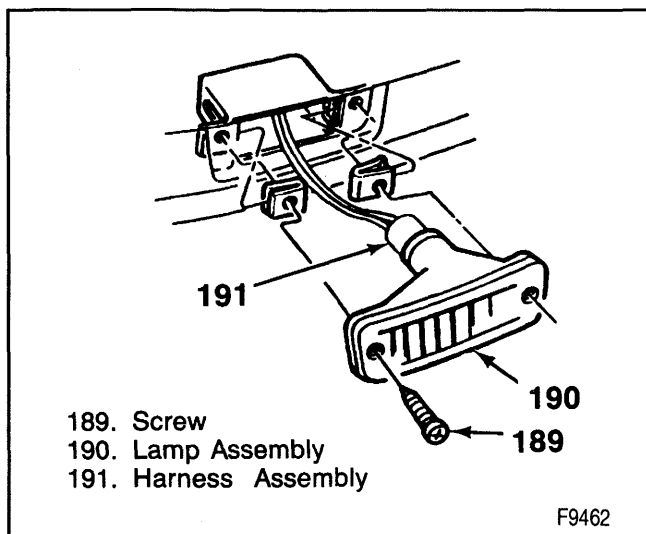


Figure 36—Rear Fender Marker Lamps

ROOF MARKER LAMP HARNESS REPLACEMENT

Remove or Disconnect (Figure 37)

- Make sure the headlamp switch is off.

1. Roof garnish molding. Refer to SECTION 10A4.
2. Roof trim panel. Refer to SECTION 10A4.
3. Electrical connector from the convenience center.
4. Roof marker lamps. Refer to "Roof Marker Lamp Replacement."
5. Electrical connector from the lamps.
6. Harness from the vehicle.

Install or Connect (Figure 37)

1. Harness to the vehicle.
2. Electrical connector to the lamps.
3. Roof marker lamps. Refer to "Roof Marker Lamp Replacement."
4. Electrical connector to the convenience center.
5. Roof trim panel and garnish molding. Refer to SECTION 10A4.

ROOF MARKER LAMP REPLACEMENT

Remove or Disconnect (Figure 37)

1. Lens screws.
2. Lens.
3. Insulator.
4. Bulb.

Install or Connect (Figure 37)

1. Bulb.
2. Insulator.
3. Lens.
4. Lens screws.

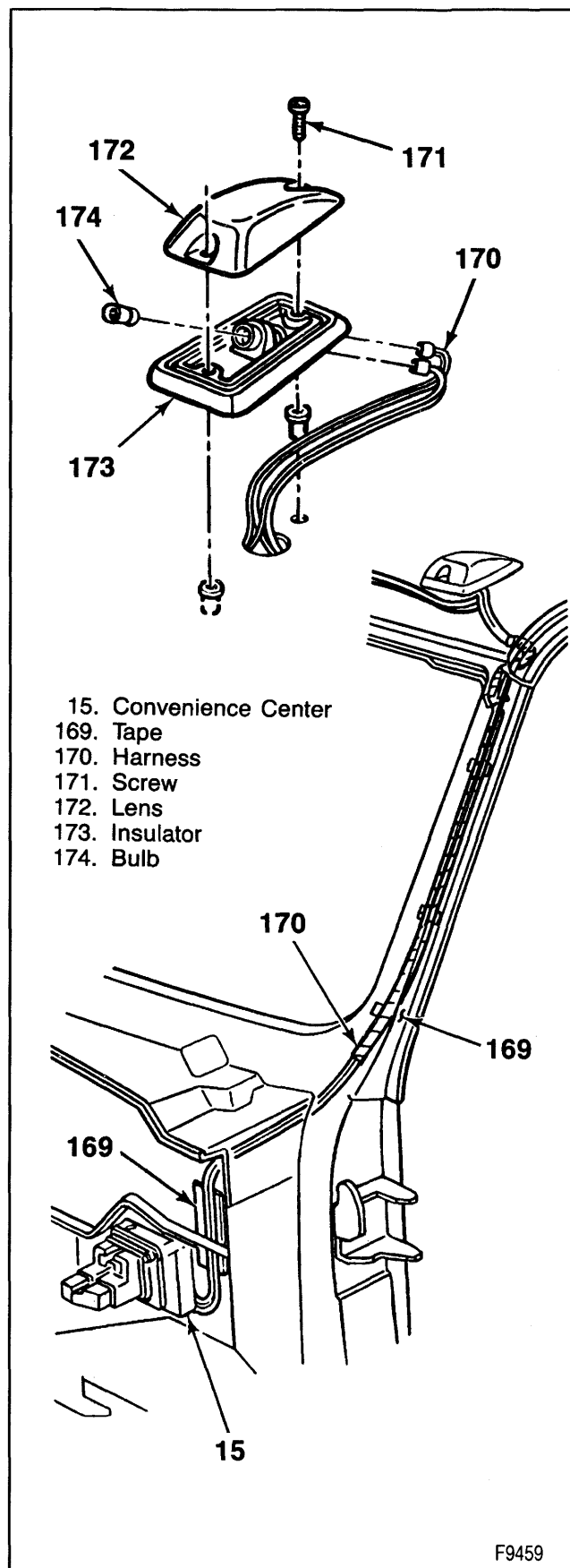


Figure 37—Roof Marker Lamp and Harness

TAILLAMP REPLACEMENT

CAB/CHASSIS

Bulb Replacement

Remove or Disconnect (Figure 38)

- Make sure the headlamp switch is off.
- 1. Four lens screws, lens, and gasket.
- 2. Bulbs.
 - Push the bulb in and turn it 1/4 turn to the left to remove it.
 - The top bulb is the backup light. The lower bulb is the stop, turn, and parking light.

Install or Connect (Figure 38)

1. Bulbs to the lamp assembly.
 - Push the bulb in and turn it 1/4 turn to the right.
2. Gasket and lens to the lamp assembly with four screws.

Lamp Assembly Replacement

Remove or Disconnect (Figure 38)

1. Lamp electrical connector from lamp assembly.
2. Nuts from the back of the bracket.
3. Lamp assembly from the bracket.

Install or Connect (Figure 38)

1. Lamp assembly to the bracket.
2. Nuts.
3. Electrical connector to the lamp assembly.

PICKUP, SUBURBAN, AND UTILITY MODELS

Remove or Disconnect (Figure 39)

- Make sure the headlamp switch is off.
- Lower the endgate.
- 1. Two screws retaining the taillamp assembly to the body.
- 2. Taillamp assembly from the vehicle.
- 3. Electrical connector from the assembly.
- 4. Bulbs from the lamp base.
 - The top bulb is a parking light.
 - The center bulb is a parking, brake, and turn indicator light.
 - The lower bulb is a backup light.
- Remove a bulb by pulling it straight out by the tabs on the base of the bulb.

Install or Connect (Figure 39)

1. Bulbs to the lamp assembly.
 - Push each bulb straight in.
2. Lamp base to the lens assembly with two screws.
3. Electrical connector.
4. Taillamp assembly to the vehicle with two screws.

UNDERHOOD REEL LAMP HARNESS REPLACEMENT

Remove or Disconnect (Figures 40 and 41)

1. Negative battery cable. Refer to SECTION 0A.
2. Junction block cover.
3. Reel lamp connector from the junction block and relay.
4. Reel lamp harness from the reel lamp.
5. Harness clips from the inner wheel well.
6. Harness from the vehicle.

Install or Connect (Figures 40 and 41)

1. Harness to the vehicle.
2. Harness clips to the inner wheel well.
3. Reel lamp harness to the reel lamp.
4. Reel lamp harness to the junction block and relay.
 - Connect the harness with the relay inboard mounting screw.
5. Junction block cover.
6. Negative battery cable.

UNDERHOOD REEL LAMP REPLACEMENT

Remove or Disconnect (Figure 40)

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connector from the lamp assembly.
3. Lamp screws.
4. Lamp assembly from the bracket.
5. Lens from the base of the assembly by pressing down on the lens and turning it until the tab on the lens clears the slot on the base. Then lift off the lens.
6. Bulb from the base.

Install or Connect (Figure 40)

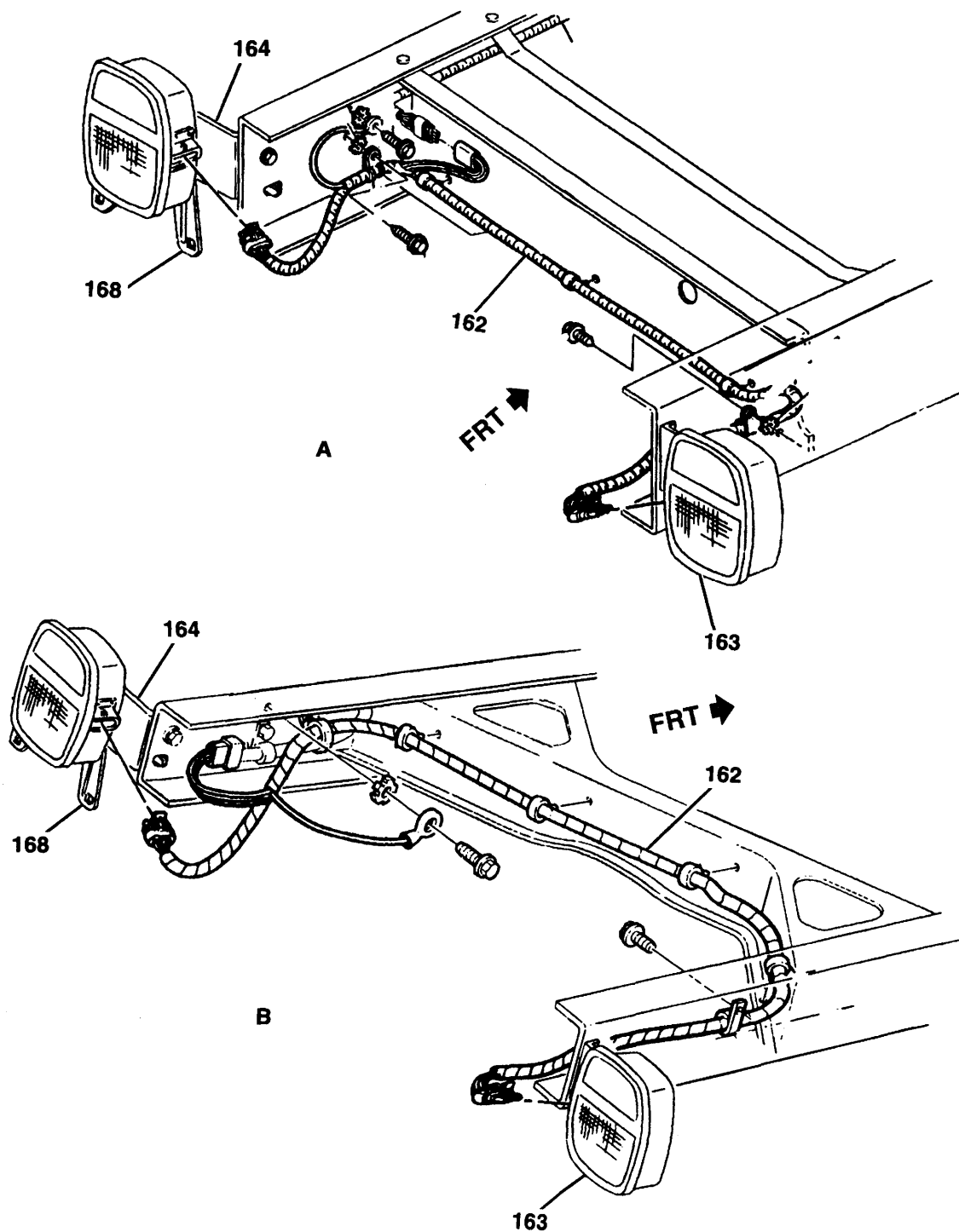
1. Bulb into the base assembly.
2. Lens onto the base.
 - Slide the tab on the lens into the slot on the base.
1. Lamp to the vehicle.
2. Lamp screws.
3. Electrical connector to the lamp assembly.
4. Negative battery cable.

UNDERHOOD STATIONARY LAMP REPLACEMENT

Remove or Disconnect (Figure 41)

1. Negative battery cable. Refer to SECTION 0A.
2. Junction block cover.
3. Wiring harness from the junction block and relay.
4. Bolts.
5. Underhood stationary lamp from the hood.

8B-34 LIGHTING SYSTEMS



- A. CAB/CHASSIS MODELS
- B. CANADIAN CAB/CHASSIS MODELS
- 162. HARNESS
- 163. ASSEMBLY, TAILLAMP
- 164. BRACKET, TAILLAMP
- 168. BRACKET, LICENSE PLATE

V3365

Figure 38—Cab/Chassis Taillamps



Install or Connect (Figure 41)

1. Underhood stationary lamp to the hood.
2. Bolts.
3. Wiring harness to the junction block and relay.
 - Connect the harness with the relay inboard mounting screw.
4. Junction block cover.
5. Negative battery cable.

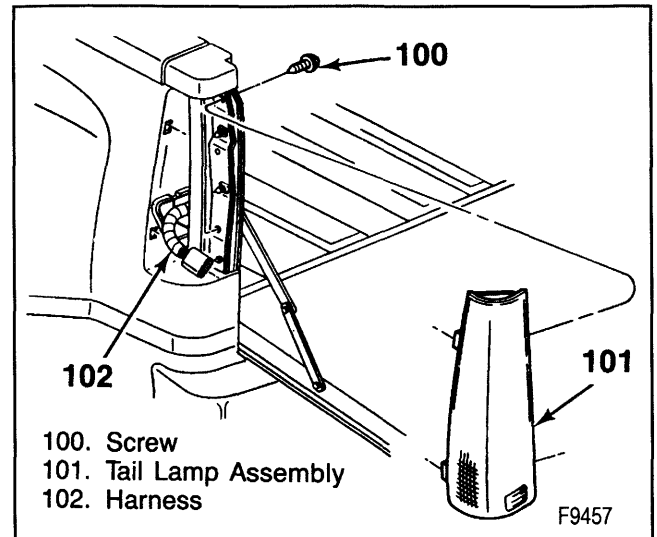


Figure 39—Taillamp Assembly

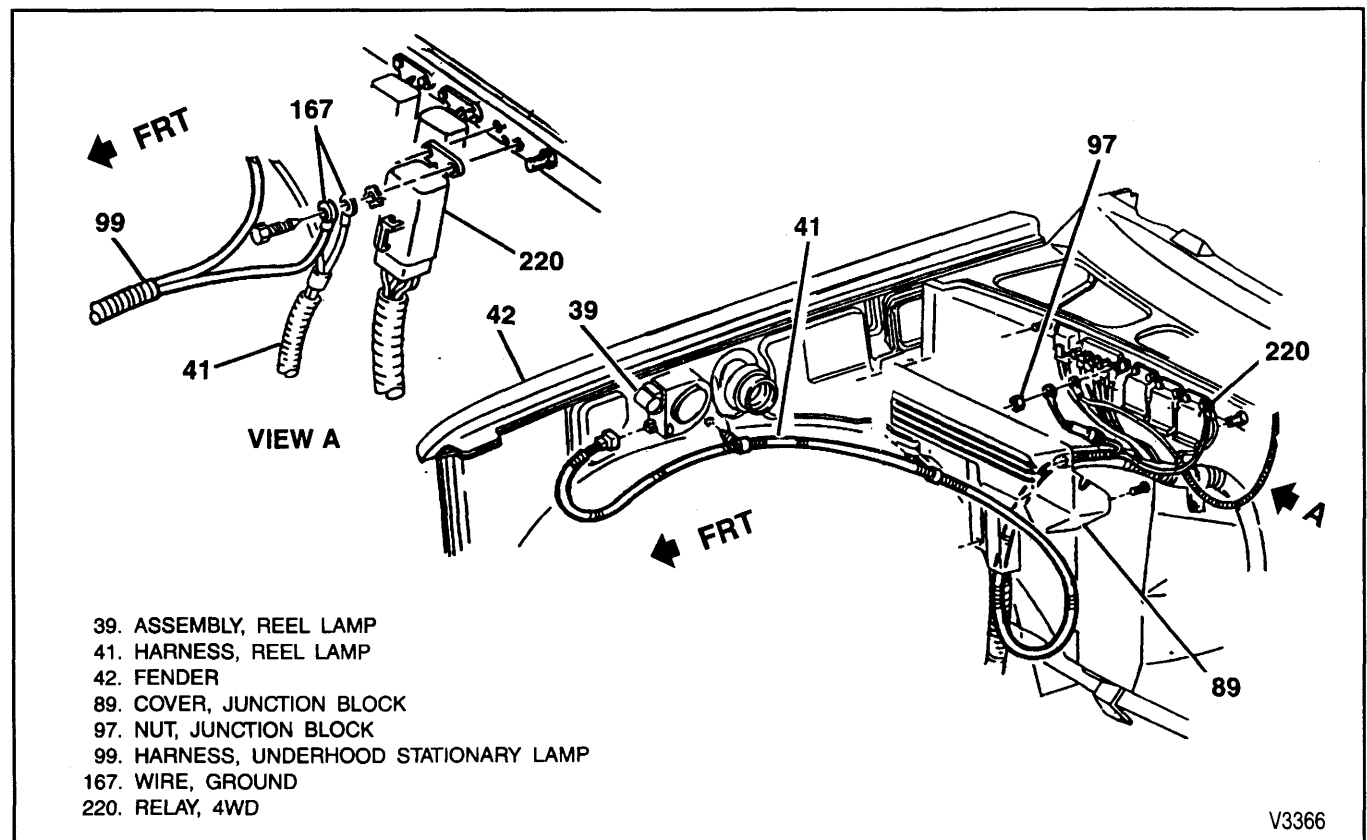


Figure 40—Underhood Reel Lamp

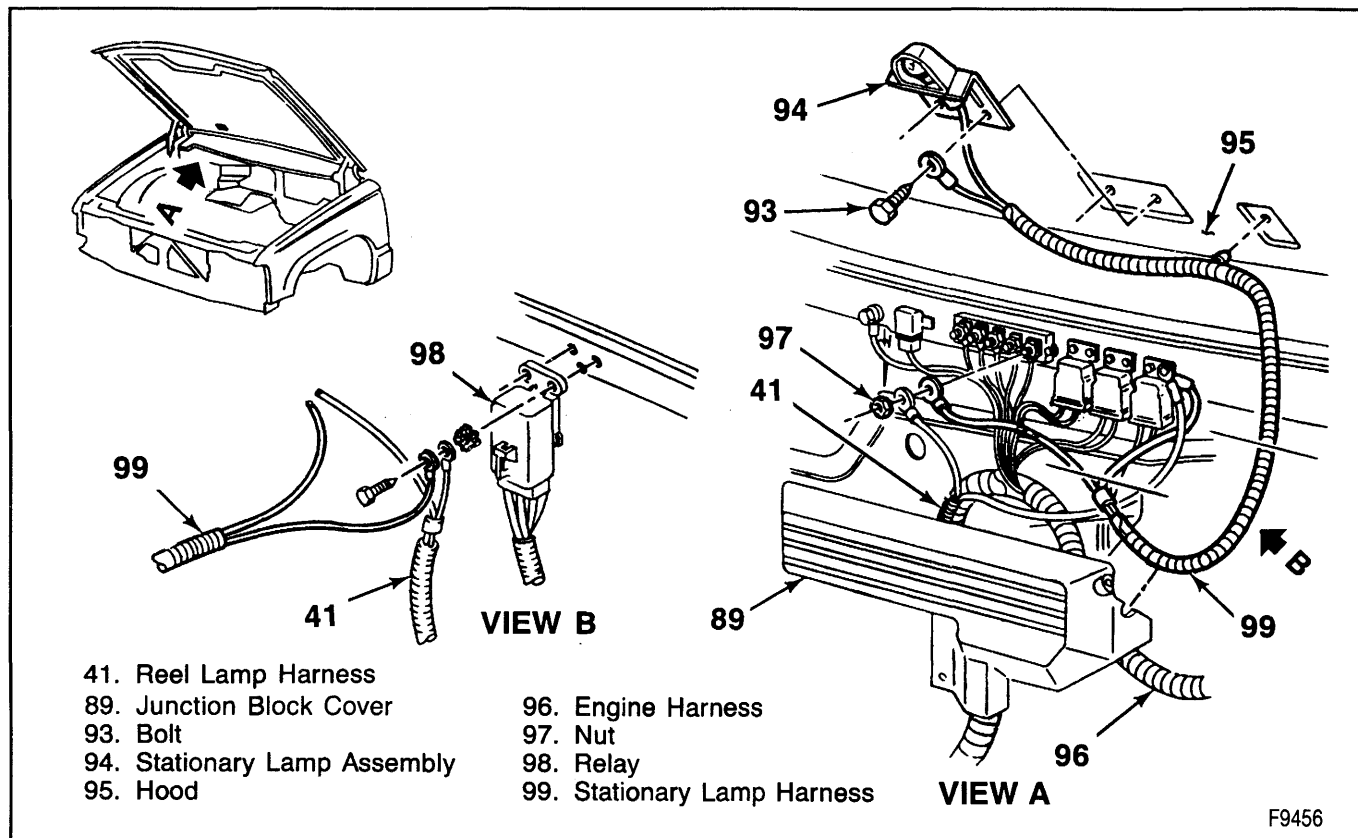


Figure 41—Underhood Stationary Lamp and Reel Lamp Harness

ON-VEHICLE SERVICE OF INTERIOR LIGHTING AND SWITCHES

ASHTRAY LAMP REPLACEMENT

↔ Remove or Disconnect (Figure 17)

- Make sure the headlamp switch is off.
- 1. Four ashtray screws.
- 2. Ashtray assembly.
- 3. Lamp assembly and shield from the top of the ashtray bracket.
- 4. Shield from the lamp assembly.
- 5. Bulb from the base by pulling it straight out.

→→ Install or Connect (Figure 17)

- 1. Bulb into the base by pushing it straight in.
- 2. Shield to the lamp assembly.
- 3. Lamp assembly and shield to the top of the ashtray bracket.
- 4. Ashtray assembly to the instrument panel with four screws.

BACKUP LAMP SWITCH REPLACEMENT

↔ Remove or Disconnect (Figure 42)

- 1. Negative battery cable. Refer to SECTION 0A.

- 2. Lower insulator panel.
- 3. Electrical connector from the switch terminals.
- 4. Switch from the steering column jacket by pulling the switch outward.

→→ Install or Connect (Figure 42)

- A. Align the actuator on the switch with the holes in the shift tube.
- B. Set the parking brake. Place the gear selector in neutral.
- C. Press down on the front of the switch until the tangs snap into the rectangular holes in the steering column jacket.

- 1. Electrical connector.

- Adjust the switch by moving the gear selector to park. The main housing and the housing back should ratchet, providing the proper switch adjustment.

- 2. Lower insulator panel.
- 3. Negative battery cable. Check for proper switch operation.

- If necessary, readjust the switch by moving the housing all the way toward the low gear position. Then repeat the adjustment procedure under step 1.

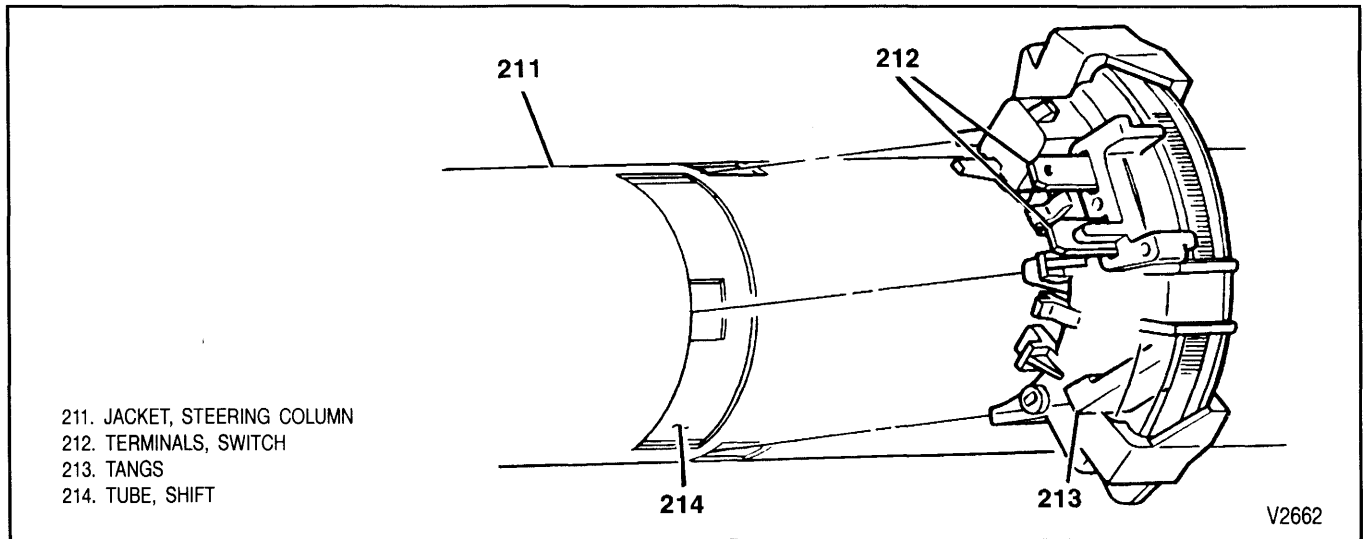


Figure 42—Backup Lamp Switch (Automatic Transmission)

CARGO/DOME LAMP AND HATCH RELEASE SWITCH REPLACEMENT

Both switches are located beneath the headlamp switch. There may be a hatch release switch on the left (for suburban or utility models) and/or an optional dome/override switch or cargo lamp switch on the right side.

↔ Remove or Disconnect (Figure 43)

1. Negative battery cable. Refer to SECTION 0A.
2. Four instrument panel bezel screws.
3. Bezel by pulling it forward slightly.
4. Wiring connectors to the headlamp, panel dimmer, cargo/dome, and rear window release switches.
5. Cargo/dome or rear window release switch from the back of the bezel.

- Squeeze the tangs together at the sides of the switch to remove it.

→← Install or Connect (Figure 43)

1. Switch into the bezel by squeezing the tangs at the side of the switch and pressing it in to the front of the bezel.
2. Electrical connectors to the back of the switches.
3. Bezel to the instrument panel with four screws.
4. Negative battery cable.

DRL MODULE AND RELAY REPLACEMENT

DRL MODULE

The DRL module consists of a circuit board in a black case. The case acts as a connector. The module breaks out of the instrument panel harness behind the left side of the instrument panel. The case is taped to the harness.

↔ Remove or Disconnect

- Make sure the ignition switch and headlamp switch are off.
- Roll back the instrument panel. Refer to "Instrument Panel Replacement" in SECTION 10A4.

1. Tape from around the case and wiring harness.

- Open the case.

2. Board from the case.

→← Install or Connect

1. New board to the case.
2. Tape to the module and wiring harness.
3. Instrument panel.

DRL RELAY

↔ Remove or Disconnect (Figure 6)

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connector.
3. Relay from the clip behind the left side of the instrument panel.

↔ Remove or Disconnect (Figure 6)

1. Relay to the clip.
2. Electrical connector.
3. Negative battery cable.

DOMELAMP REPLACEMENT

↔ Remove or Disconnect (Figure 44)

1. Negative battery cable. Refer to SECTION 0A.
2. Lens.
3. Bulb.
4. Housing screws.
5. Housing assembly or lamp assembly.
6. Electrical connector.

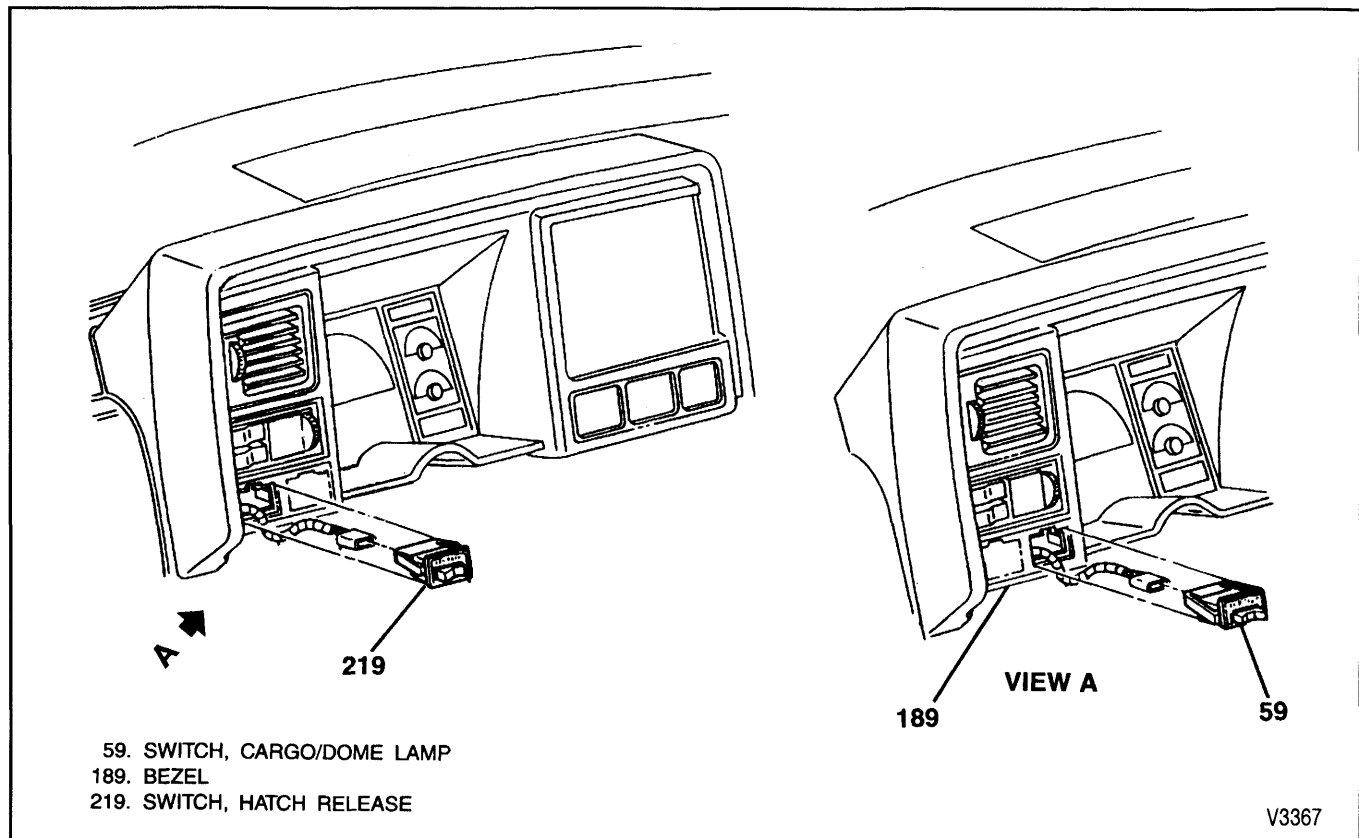


Figure 43—Cargo/Dome Lamp Switch

7. Bezel.

Install or Connect (Figure 44)

1. Bezel.
2. Electrical connector.
3. Housing assembly or lamp assembly.
4. Housing screws.
5. Bulb.
6. Lens.
7. Negative battery cable.

DOOR JAMB SWITCH REPLACEMENT

Remove or Disconnect (Figure 17)

1. Negative battery cable. Refer to SECTION 0A.
 - Reach up under the instrument panel, squeeze the switch tangs together, and push the switch through the side of the instrument panel.
2. Door jamb switch electrical connector.
3. Door jamb switch.

Install or Connect (Figure 17)

1. Door jamb switch to the electrical connector.
 - Squeeze the switch tangs together, and push the switch into the side of the instrument panel.
2. Negative battery cable.

FOG LAMP SWITCH REPLACEMENT

Remove or Disconnect (Figure 2)

1. Negative battery cable. Refer to SECTION 0A.
2. Bezel from the instrument panel.
3. Fog lamp switch electrical connector at the back of the bezel.
4. Fog lamp switch from the front of the bezel.
 - Squeeze the tangs together at the sides of the switch and push the switch forward.

Install or Connect (Figure 2)

1. Fog lamp switch to the bezel.
2. Electrical connector to the switch.
3. Bezel to the instrument panel.
4. Negative battery cable.

FOUR-WHEEL DRIVE INDICATOR LAMP REPLACEMENT

Remove or Disconnect (Figure 45)

- Make sure the headlamp switch is off.
1. Shift lever knob by unscrewing it.
 2. Four bezel screws.
 3. Transfer case bezel.

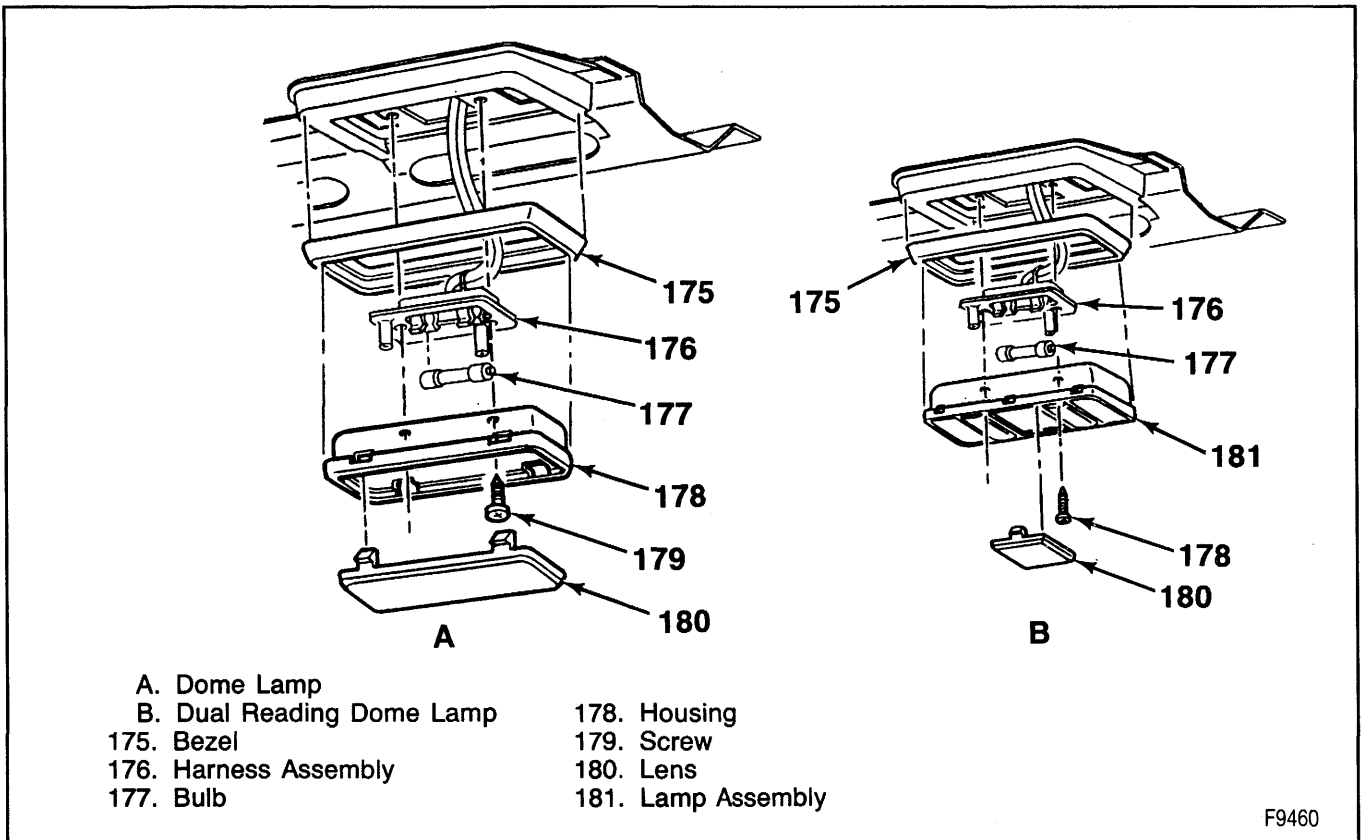


Figure 44—Dome Lamp Replacement

4. Bulbs from the sockets by pulling them straight out.

Install or Connect (Figure 45)

1. Bulbs into the sockets by pushing them straight in.
2. Bulbs and sockets into the back of the bezel.
3. Bezel to the floor with four screws.
4. Shift lever knob.

HEADLAMP SWITCH REPLACEMENT

Remove or Disconnect (Figure 46)

1. Negative battery cable. Refer to SECTION 0A.
2. Bezel.
3. Headlamp switch, cargo lamp switch, fog lamp switch, and defogger switch electrical connectors.
4. Four switch to bezel screws.
5. Headlamp switch assembly from the back of the bezel.
6. Headlamp switch and/or panel dimmer switch from the mounting switch mounting plate.

Install or Connect (Figure 46)

1. Headlamp switch and/or panel dimmer switch to the mounting plate.
2. Switch assembly to the back of the bezel with four screws.

3. Electrical connectors to the back of the switches in the bezel.
4. Bezel to the instrument panel.
5. Negative battery cable.

INSTRUMENT PANEL COMPARTMENT LAMP AND SWITCH REPLACEMENT

LAMP

Remove or Disconnect (Figure 17)

- Make sure the headlamp switch is off.
- 1. Instrument panel compartment screws.
- 2. Instrument panel compartment.
- 3. Bulb from behind the instrument panel by pulling it straight out.

Install or Connect (Figure 17)

1. Bulb into the socket by pushing it straight in.
2. Instrument panel compartment with screws.

SWITCH

Remove or Disconnect

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel compartment.
3. Switch cover from the front of the instrument panel.

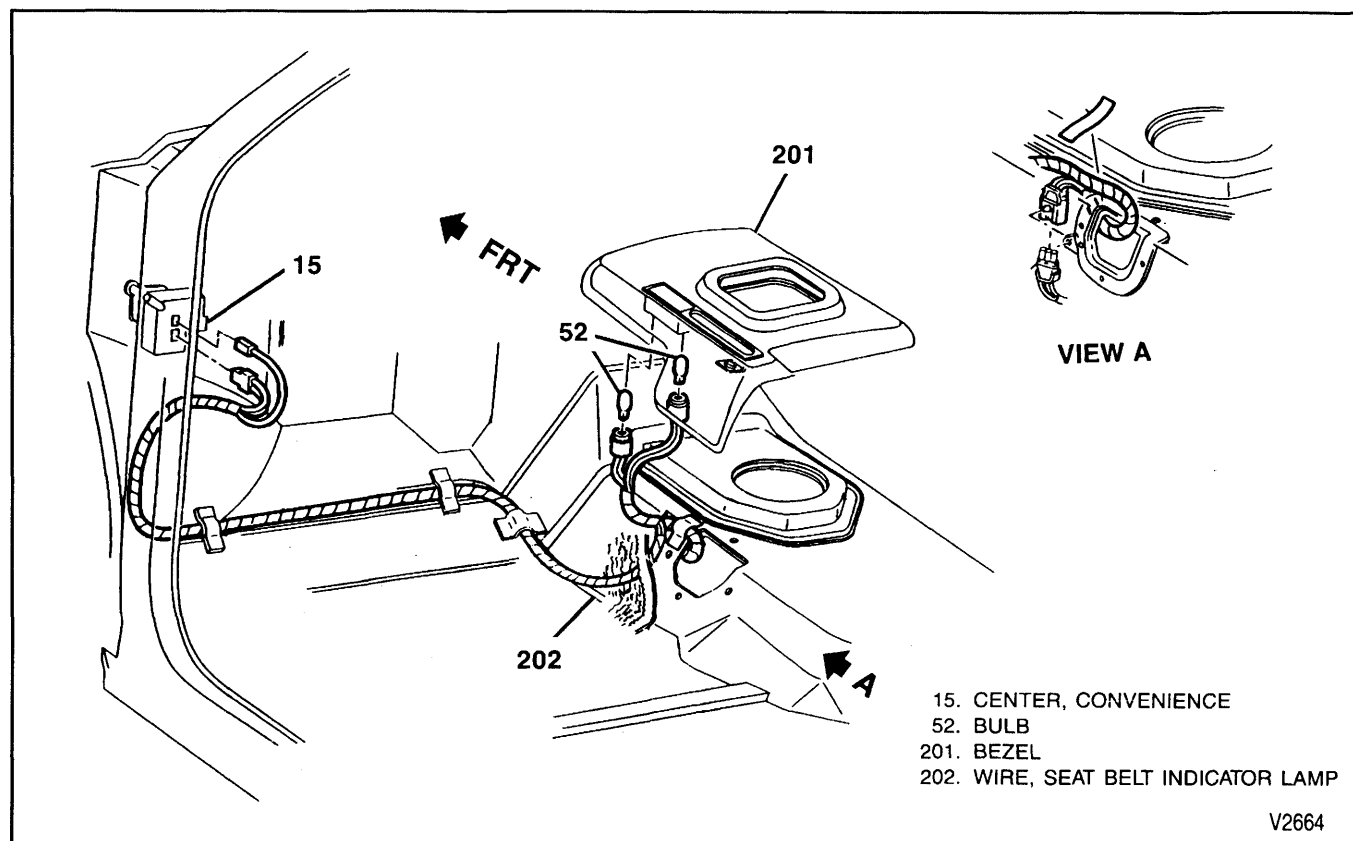


Figure 45—Four-Wheel Drive Indicator Lamps

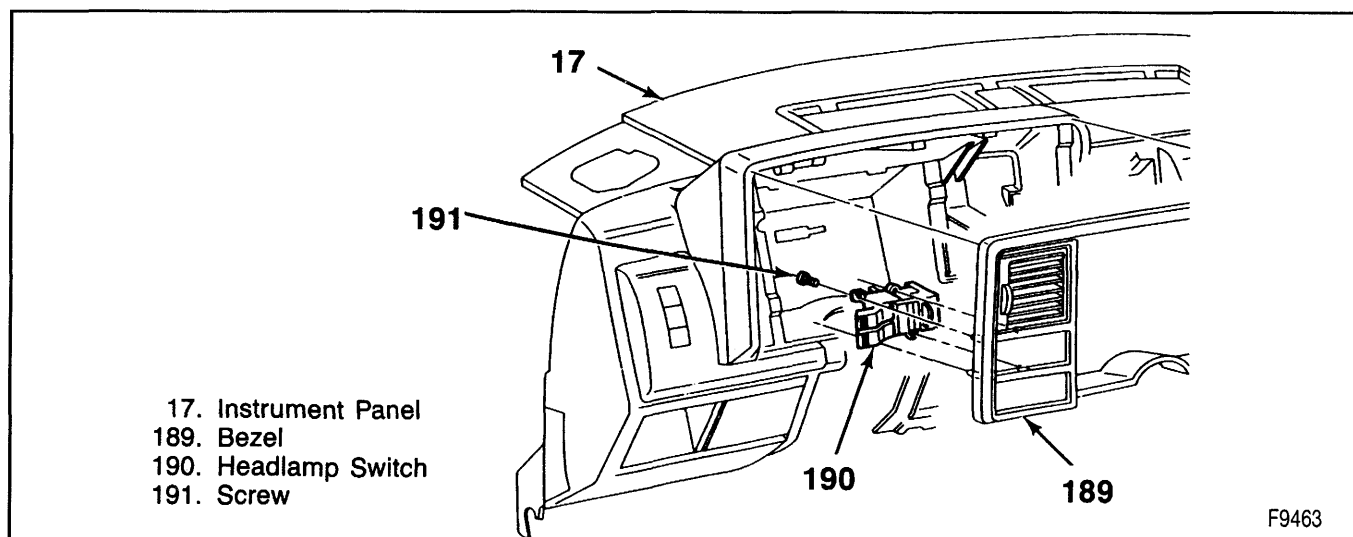


Figure 46—Headlamp Switch

4. Switch from behind the instrument panel.
 - Lift up the tab on the switch to remove the two wire connectors.

Install or Connect

1. Wire connectors to the switch.
 - Push down the tab on the switch to hold the wire connectors.
2. Switch to the back of the instrument panel.
3. Switch plate to the front of the instrument panel.
4. Instrument panel compartment with screws.
5. Negative battery cable.

OVERHEAD CONSOLE AND LAMP REPLACEMENT

LAMP REPLACEMENT

Remove or Disconnect (Figure 47)

1. Negative battery cable. Refer to SECTION 0A.
2. Lamp assembly.
 - A. Push upward against the reading lamp assembly and turn it to the left.
 - B. Lower the assembly from the console.

3. Bulb and base from the back of the assembly.
4. Bulb from the base by pulling it straight out.

↔ Install or Connect (Figure 47)

1. Bulb into the base by pushing it straight in.
2. Bulb and base into the lens and socket assembly.
3. Lamp assembly into the console by pushing it in and turning it to the right.
4. Negative battery cable.

CONSOLE REPLACEMENT

↔ Remove or Disconnect (Figure 47)

1. Negative battery cable. Refer to SECTION 0A.
2. Console screw from the front of the console.
 - Lift the console from the slots in the headliner, slide it forward, and lower it.
3. Wiring connector at the back of the console.

↔ Remove or Disconnect (Figure 47)

1. Electrical connectors to the back of the console.
2. Tabs on the end of the console into the slots in the headliner.
3. Screw through the front of the console.
4. Negative battery cable.

SUNSHADE VANITY MIRROR LAMP REPLACEMENT

The vanity mirror assembly is an integral part of the sunshade. If it is damaged, the sunshade assembly must be replaced. Only the lamps can be replaced separately.

↔ Remove or Disconnect (Figure 48)

- Lift the cover on the vanity mirror.
1. Lamp lens by prying it out.
 2. Lamp bulb by gently prying it out.

↔ Install or Connect (Figure 48)

1. New lamp bulb by pressing it in.
2. Lamp lens.

TRANSMISSION INDICATOR (PRNDL) LAMP REPLACEMENT

On vehicles with automatic transmissions, the transmission indicator and lamp are part of the instrument cluster. The bulb and base are one assembly. For replacement instructions, refer to SECTION 8C.

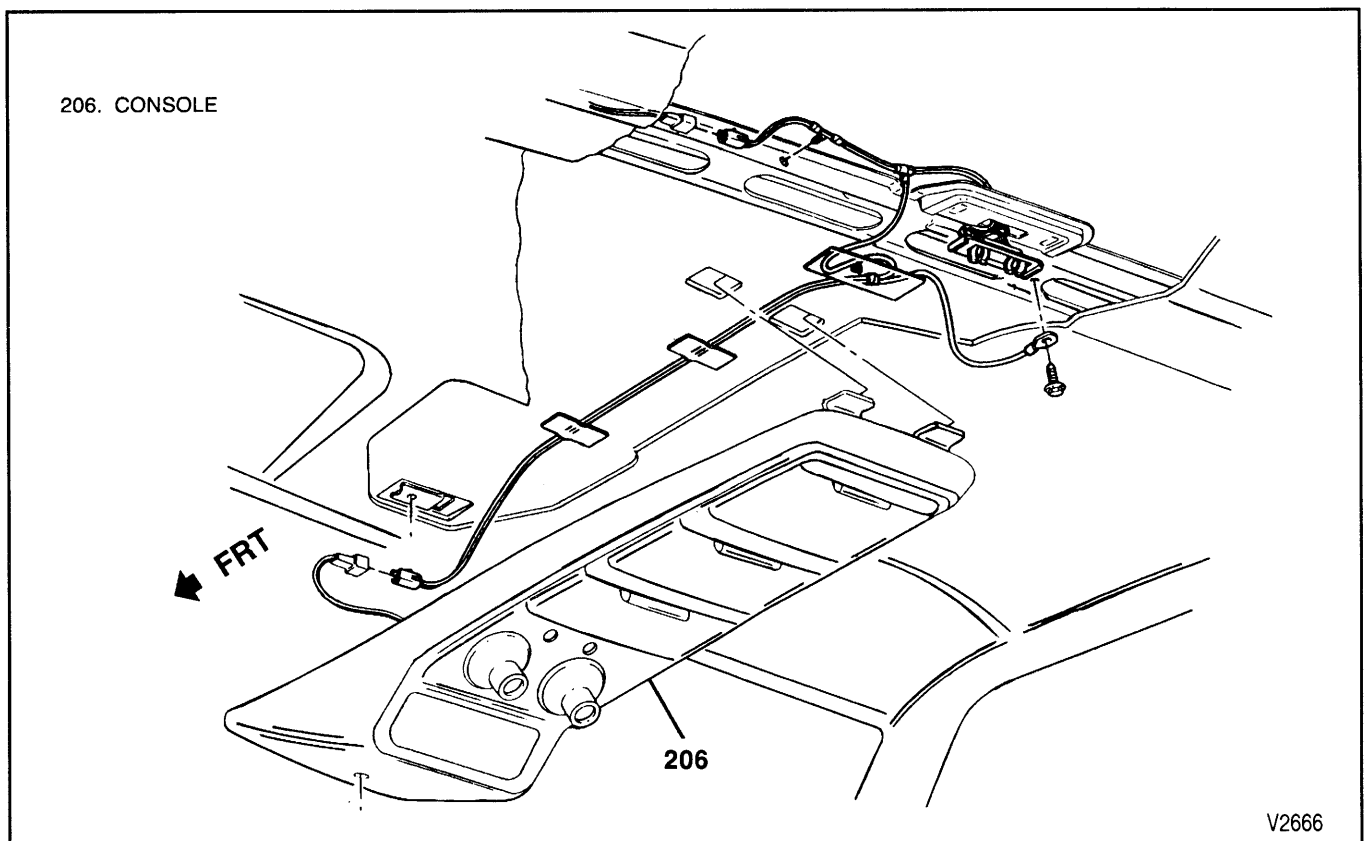


Figure 47—Overhead Console

V2666

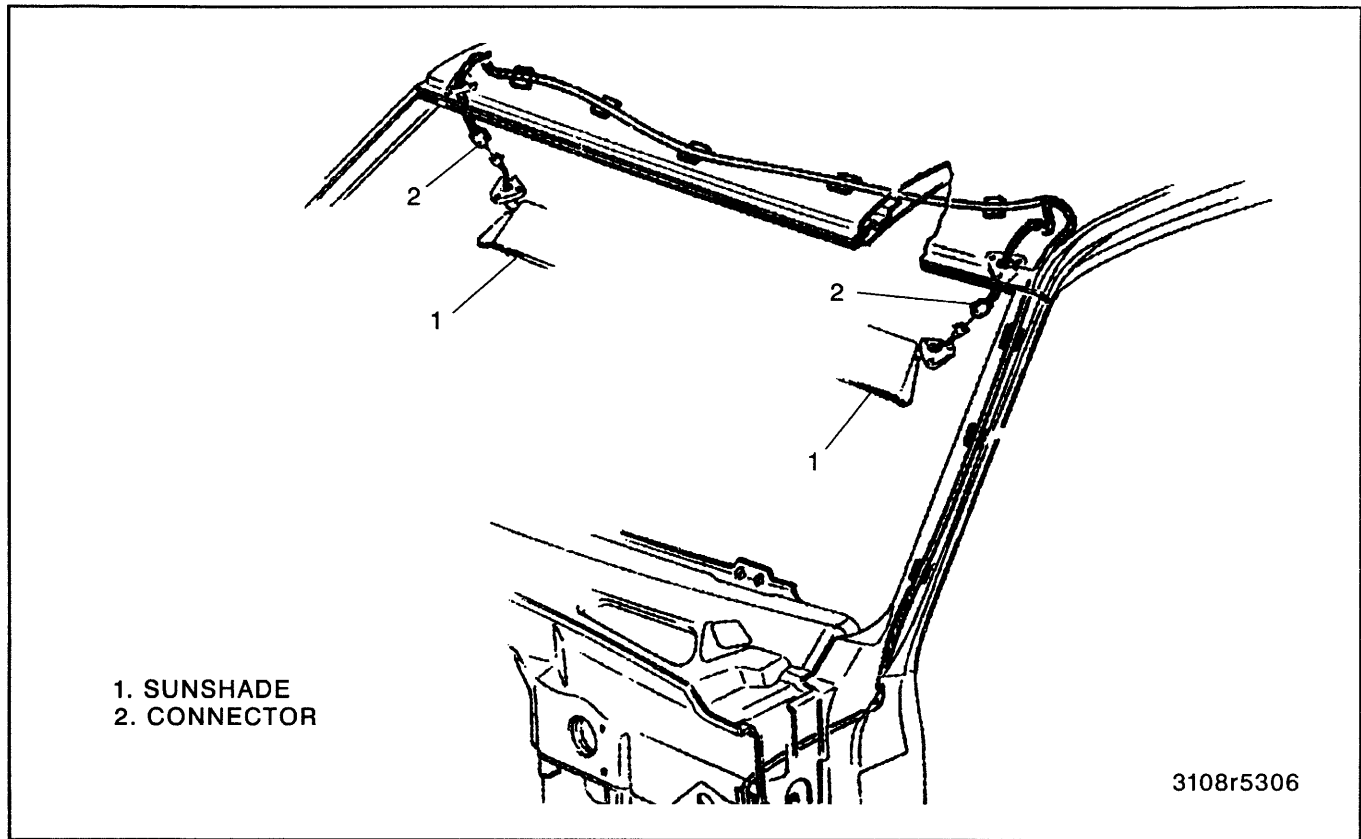


Figure 48—Sunshade with Lighted Vanity Mirror

SPECIFICATIONS

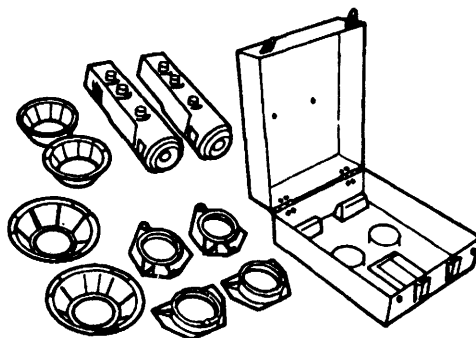
Lamp or Bulb	Trade No.	Power Rating at 12.8V, Watts	Quantity			
			Pickup	Crew Cab	Utility	Suburban
Exterior Lights:						
Headlamps: 2 Headlamp System	6052	55/65	2	2	2	2
Halogen (Opt.)	H6054	35/65	2	2	2	2
Headlamps: 4 Headlamp System	9005	65	2	2	2	2
(Composite)	9006	55	2	2	2	2
		Candle Power				
Fog Lamp	H3	115	2	—	—	—
Front Marker Lamp	194	2	2	2	2	2
Front Park and Turn Lamp	2357NA	30/2	4	4	4	4
Rear Parking Lamp	3057	32-2	2	2	2	2
Rear Stop and Turn Lamp	3057	32-2	2	2	2	2
Backup Lamp	3156	32	2	2	2	2
Backup Lamp (Cab/Chassis Only)	1156	32	2	2	—	—
Rear Park, Stop, and Turn Lamp (Cab/Chassis Only)	1157	32-3	2	2	—	—
Fender Clearance Lamp	194	2	4	4	—	—
Roof Marker Lamp	194	2	5	5	—	5
CHMSL Bulb	921	32	1	1	—	—
License Plate Lamp	194	2	2	2	2	2
Underhood Lamp	93	15	1	1	1	1
Reel Lamp	232	10	1	1	1	1
Interior Lights:						
Dome Lamps	211-2	12	1	2	2	2
Reading Lamps	211-2	12	2	4	4	4
Roof Console Lamps	168	3	—	2	2	2
Courtesy Lamp	1003	15	2	2	2	2
Heater or A/C Control Lamp	194	2	1	1	1	1
Four Wheel Drive Indicator	161	1	1	1	1	1
Four Wheel Drive Shift Lever	194	1	1	1	1	1
Instrument Panel Compartment Lamp	194	2	1	1	1	1
Ashtray Lamp	194	2	1	1	1	1
Sunshade Vanity Mirror	74	0.7	—	4	4	4
Instrument Panel Lights						
Transmission Indicator (PRNDL)	161	1	1	1	1	1
Daytime Running Lights Indicator†	74	.7	1	1	1	1
Charging System Indicator Lamp	74	.7	1	1	1	1
Instrument Cluster	194	.2	4	4	4	4
Illuminating Lamps	194	.2	6	6	6	6
Headlamp Beam Indicator	74	.7	1	1	1	1
Directional Signal Indicator	74	.7	2	2	2	2
Brake Warning Indicator	74	.7	1	1	1	1
Safety Belt Warning	74	.7	1	1	1	1
Check Gages Indicator	74	.7	1	1	1	1
Malfunction Indicator ("Service Engine Soon")	74	.7	1	1	1	1
Malfunction Indicator ("Service Throttle Soon")	74	.7	1	1	1	1
Upshift Indicator	74	.7	1	1	1	—
ABS Warning Indicator	74	.7	—	—	1	1
Wait Lamp*	74	.7	1	1	—	—
Low Coolant Lamp*	74	.7	1	1	—	—
Service Fuel Filter Lamp*	74	.7	1	1	—	—

*Diesel only †Canadian Vehicles only

T2857

SPECIAL TOOLS

1



J 25300-B

1. Headlight Aimer

F9468

SECTION 8C

INSTRUMENT PANEL AND GAGES

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

INSTRUMENT PANEL AND GAGES

The instrument panel is designed to allow the removal of all control switches from the driver's side (figure 1). The standard instrument cluster is equipped with mechanical gages that show engine oil pressure, coolant temperature, and charging system voltage (figures 2 and 4). An optional cluster includes an analog tachometer (figures 3 and 4).

NOTICE: When replacing a speedometer or odometer assembly, federal law requires that the odometer reading of the replacement unit be set to register the same mileage as the prior odometer. If the same mileage cannot be set, the law requires that the replacement odometer be set at zero and a label be installed on the driver's door frame to show the previous odometer reading and the date of replacement.

ELECTRIC SPEEDOMETER

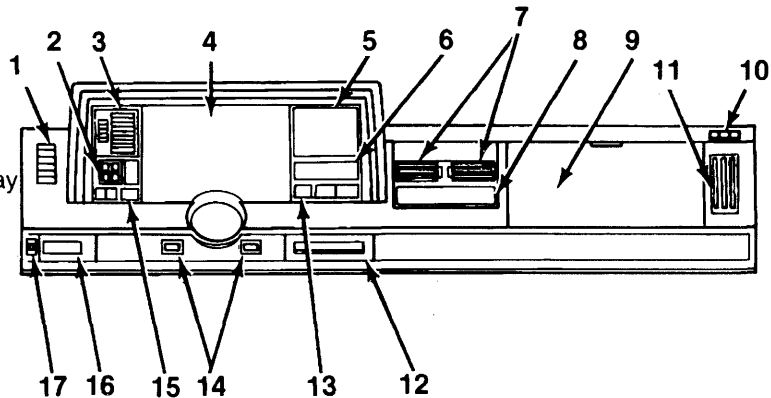
The instrument cluster contains a high-torque type electric speedometer. The electro-mechanical gages are individually plugged into socket-type metal connectors in the cluster case. Integrated circuits control the air core speedometer and stepper motor odometer. Lighting is provided by removable bulb and socket assemblies that insert into the back of the instrument cluster.

The speedometer system consists of the instrument cluster, vehicle speed sensor (VSS) calibrator, vehicle speed sensor (VSS), and related wiring.

The one-piece instrument cluster mounts in front of the driver in the instrument panel and is not serviceable. If diagnosis leads to a malfunctioning instrument cluster, it must be replaced. Repairs to the instrument cluster can only be performed by an authorized instrument cluster service center.

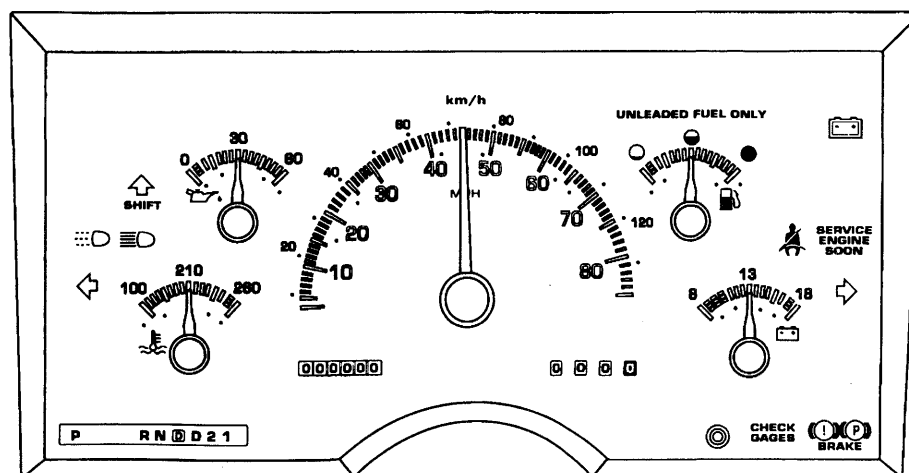
The vehicle speed sensor calibrator (VSS calibrator) is a solid-state device that changes the analog output from the vehicle speed sensor (VSS) to a digital signal

1. Left Side Window Defogger
2. Main Light Switch
3. Vent
4. Instrument Cluster
5. Radio or Storage Area
6. Air Conditioner/Heater
7. Vents
8. Tape Player/Equalizer or Storage Tray
9. Glove Box
10. Right Side Window Defogger
11. Vent
12. Ash Tray
13. Rear Window Defogger
14. Air Vent Handles
15. Cargo Lamp Switch
16. Fuse Panel
17. Parking Brake Release



F3561

Figure 1—Instrument Panel and Controls



V2655

Figure 2—Gage Cluster—Gasoline Models

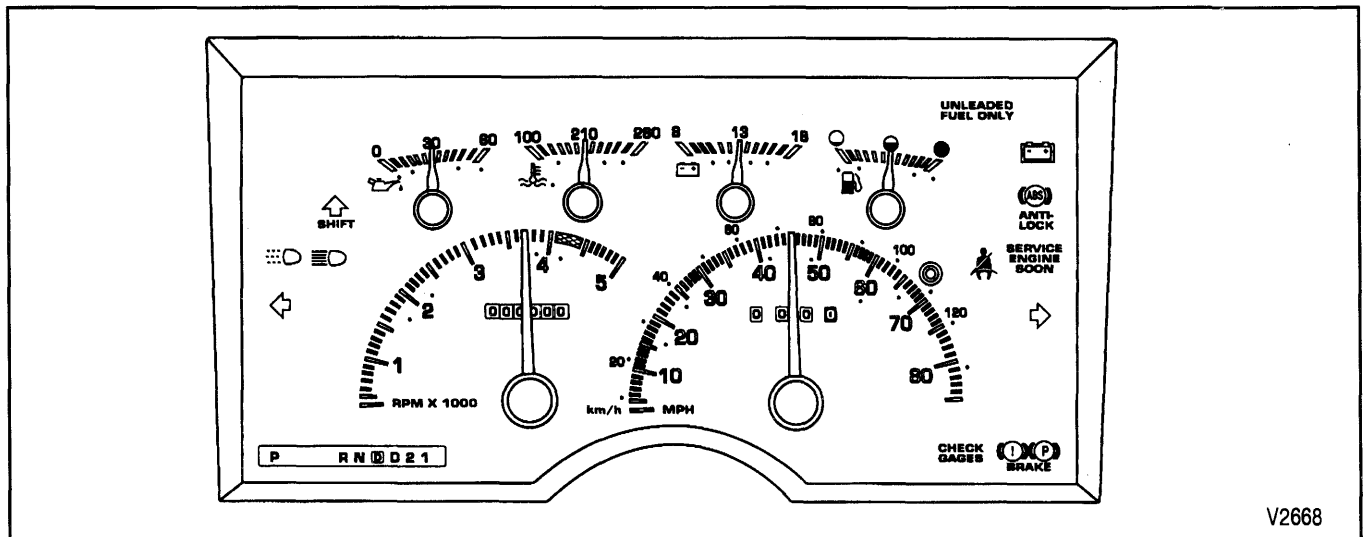


Figure 3—Tachometer Cluster—Gasoline Models

containing 4000 pulses per mile (PPM) for the instrument cluster. The VSS calibrator is matched to the final drive and tire size of each vehicle. It must be replaced with the proper VSS calibrator part number to match that vehicle. If the final drive or tire size is changed for any reason, replace the VSS calibrator to match the new final drive or tire size. If not, the signal will not be accurate for proper speedometer/odometer operation. An incorrect VSS calibrator can also affect antilock brakes, vehicle control module (VCM), and cruise control systems.

The VSS calibrator attaches to the passenger side of the instrument panel near the instrument panel storage compartment with hook and loop type fastener. All powertrain combinations use a separate VSS calibrator.

The vehicle speed sensor (VSS) is a permanent magnet signal generator that sends an analog signal proportional to the propeller shaft speed to the VSS calibrator. The VSS mounts to the transmission tailshaft extension housing on two-wheel drive models and the transfer case output shaft housing on four-wheel drive models. Refer to SECTION 7A and 7B for VSS replacement procedures.

TACHOMETER

An optional tachometer indicates engine speed in revolutions per minute (RPM) with the ignition switch in the "RUN" position. A wire to the "TACH" connector on the ignition control module (gasoline engines) or this "I" terminal on the generator (diesel engines) measures the ignition pulses of the module. An electronic circuit on the tachometer converts these pulses to an analog display.

FUEL GAGE

The fuel gage indicates the quantity of fuel in the tank when the ignition switch is in the "RUN" position. When the ignition switch is turned to the "OFF," "LOCK," "START," or "ACC" position, the pointer may come to rest at any position.

The fuel gage measures current from a variable resistor inside the fuel tank that is controlled by a float. When the fuel tank is full and the ignition switch is in the "RUN" position, resistance is high and the fuel gage

indicator moves to the maximum position, or FULL on the gage face. When the fuel tank is empty, resistance is low and the fuel gage indicator moves to the minimum position, or EMPTY on the gage face. Corroded connections or severed ground paths generally cause the indicator to register past FULL on the gage face. Short circuits to ground generally result in the indicator resting below EMPTY.

The fuel gage sender assembly mounts to the top of the fuel tank and is retained by a cam-type locking ring. A seal is used between the fuel tank and the sender. The fuel gage sender assembly consists of float attached to a variable resistance sender, a woven plastic filter on the fuel pickup tube, and a vane-type electric fuel pump. For fuel gage sender replacement procedures, refer to the Driveability, Emissions, and Electrical Diagnosis Manual.

The fuel gage sender will have two or three hose connections. One is used for the fuel feed hose, the second connects to the vapor canister, and the third is used for the fuel return line to the fuel tank. On some fuel tank senders, a short connector lead is used while others have the connector attach directly to the sender.

COOLANT TEMPERATURE GAGE

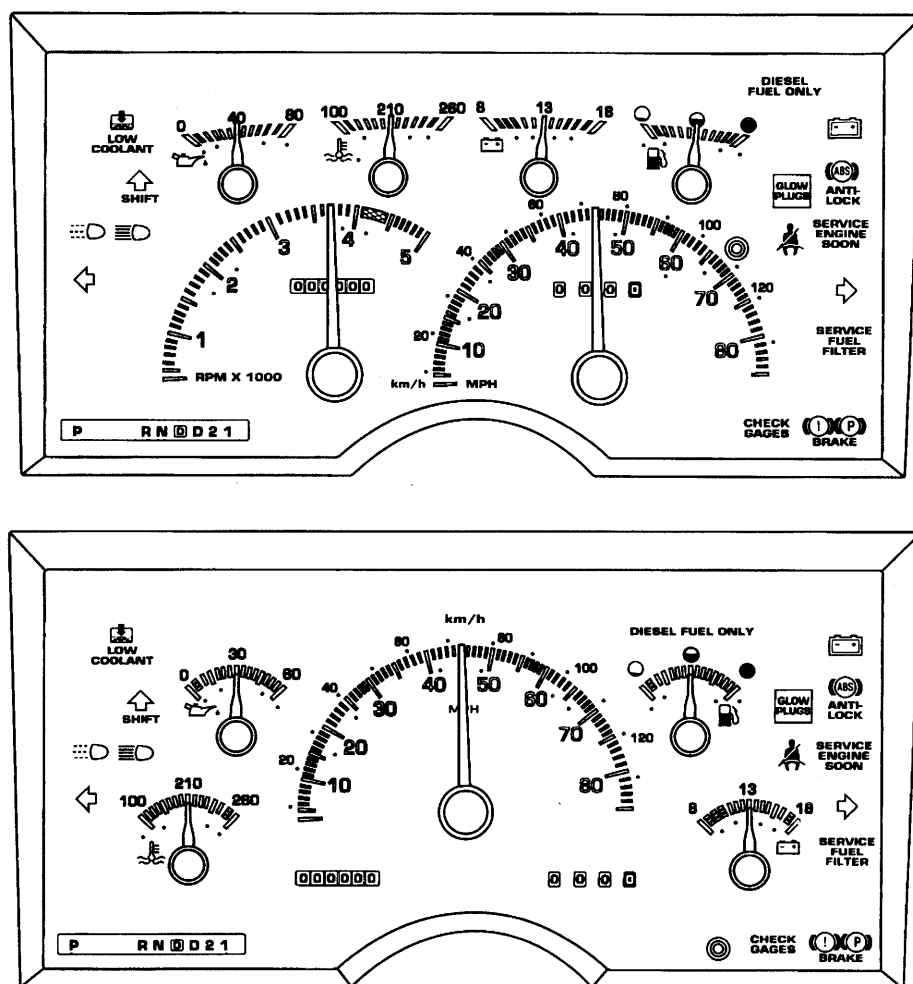
The coolant temperature gage measures current from a variable resistance sensor in the engine coolant jacket with the ignition switch in the "RUN" position. The sensor changes resistance with coolant temperature. As coolant temperature increases, the resistance of the sensor decreases.

The coolant temperature sensor (CTS) is located in the middle of the cylinder head on the driver's side of the vehicle for the 4.3L, 5.0L, 5.7L, and 7.4L engines. The 6.5L diesel engine has a coolant temperature sender at the front of the cylinder head.

OIL PRESSURE GAGE

The oil pressure gage indicates engine oil pressure with the ignition switch in the "RUN" position. An oil pressure sender in the engine block changes resistance with oil pressure.

8C-4 INSTRUMENT PANEL AND GAGES



V2669

Figure 4—Gage and Tachometer Cluster—Diesel Models

The oil pressure gage sender is located at the front of the engine block on the 7.4L engine. On all other engines, including diesels, the oil pressure sender is located at the rear of the engine block.

VOLTMETER

The voltmeter indicates nominal electrical system voltage. When the engine is running, the indicator should be between 10 and 16 volts. If the indicator is not within these limits with the engine running, refer to SECTION 6D3.

The voltmeter has a red band at each extreme end of its range. It is normal operation for the indicator to rest just outside of either band. If the indicator rests inside either band, a charging system problem is indicated.

CHARGING SYSTEM WARNING LAMP

The charging system warning lamp appears on the instrument cluster as a battery symbol. It turns on when the ignition switch is in the "RUN" position and the

engine is not running. It turns off when the engine is running, if the charging system functions properly. A charging system malfunction is indicated when the charging system warning lamp is on with the engine running. This warning lamp will glow at full brilliance, not half lit, when a charging system malfunction occurs or system voltage is too high or too low.

MALFUNCTION INDICATOR LAMP (MIL)

The malfunction indicator lamp (commonly known as MIL or "Service Engine Soon") should turn on with the ignition switch in the "RUN" position and the engine off. The lamp should turn off one to five seconds after the engine starts. If the lamp stays on or turns on while driving, service to the emission control system may be required. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.

“SERVICE THROTTLE SOON” INDICATOR LAMP

All vehicles equipped with diesel engines have an electronic throttle control. Throttle cables are no longer used on diesel engines. An electronic throttle pedal assembly sends signals to the powertrain control module (PCM). The PCM collects this throttle position signal, compares it with information such as road speed, and transmission range, and signals a solenoid on the injector pump assembly. In this manner, precise control is kept over the entire diesel throttle system.

The “Service Throttle Soon” lamp will appear in the instrument cluster on vehicle's with diesel engines. It will turn on when the ignition switch is in “RUN” and the engine is off. The lamp should turn off one to five seconds after the engine starts. If the lamp stays on or turns on while driving, service to the electronic throttle system may be required. Refer to the Driveability, Emissions, and Electrical Diagnosis Manual.

BRAKE WARNING SYSTEM

The brake warning system consists of two lamps in the instrument cluster; the brake warning lamp and the antilock indicator lamp.

The brake warning lamp indicates that a low fluid pressure condition exists in the brake system when it finds ground through the pressure differential switch in the combination valve. It also indicates the parking brake is applied when it finds ground through the parking brake switch. For additional information on the brake warning lamp operation, refer to SECTION 5.

The “ANTILOCK” lamp serves as an indication of four wheel antilock system operation and malfunctions. A bulb check is done each time the ignition switch is turned to the “RUN” position. The lamp should turn on and remain on for about two seconds. To determine the specific cause of a system malfunction, refer to SECTION 5E1.

“CHECK GAGES” LAMP

The “CHECK GAGES” lamp turns on when engine coolant temperature is too high and/or engine oil pressure is too low. Signals from the engine coolant temperature sensor and engine oil pressure sender are monitored by the check gages lamp driver. The check gages lamp driver is part of the temperature gage circuit board inside the instrument cluster and controls current to the “CHECK GAGES” lamp.

UP-SHIFT INDICATOR LAMP (MANUAL TRANSMISSION ONLY)

The up-shift indicator in the instrument cluster turns on to indicate optimum shift points for maximum fuel economy. When this lamp turns on, shift the transmission to the next higher gear range, if conditions permit.

Control of the up-shift indicator is a function of the powertrain control module (PCM). Several conditions are monitored, such as engine speed, load, and throttle position to turn on the lamp. If the lamp is erratic or inoperative, verify the integrity of the circuit, then replace the PCM if no resolution is found.

INSTRUMENT PANEL HARNESS

This harness is located along the upper back edge of the instrument panel. It starts from the convenience center, which is located at the left side of the instrument panel, and goes up the left side of the instrument panel, then across to the right side of the cab (figure 5).

As the harness routes across the instrument panel, various circuits branch off to the switches, indicators, and instrument cluster. The harness is held in place with bendable clips.

Other harnesses are carried along the same supports. These harnesses consist of wiring for the power door locks, power windows, radio, heater, and air conditioning.

HEATER AND AIR CONDITIONING HARNESS

The harness begins at the convenience center and branches up to the heater and air conditioning control unit (figure 5). It then branches to the blower motor and relays. Refer to SECTION 1A and SECTION 1B for further information.

FUSE BLOCK AND CONVENIENCE CENTER

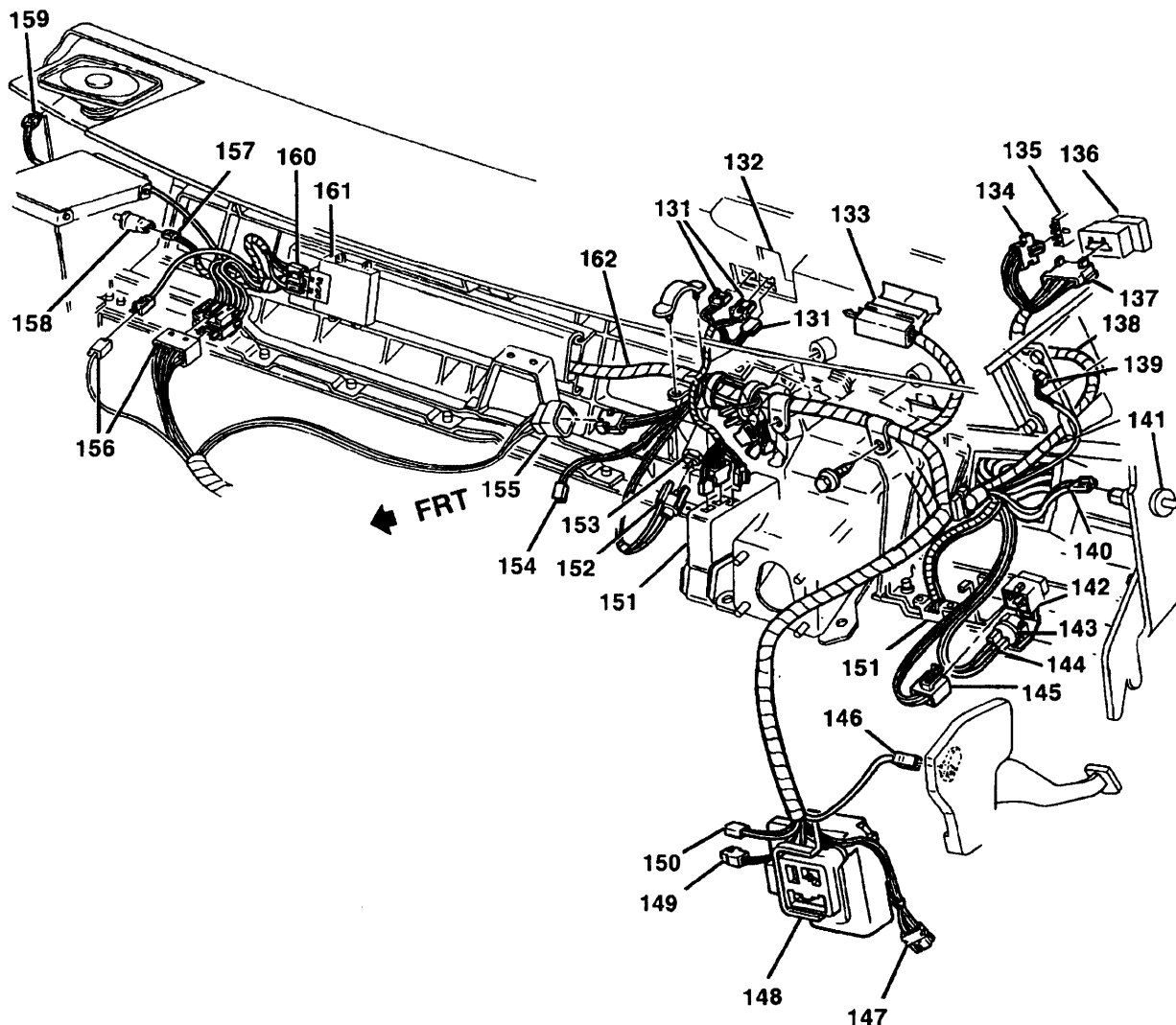
The fuse block is located behind a pull cover in the instrument panel to the left of the steering column.

The fuse block contains fuses and circuit breakers for several individual circuits within the vehicle.

The convenience center is located just below the instrument panel on the driver's side. It contains individual relays such as: the seat belt and ignition key alarm, horn relay, and flasher.

For further information about the fuse block or convenience center, refer to the Driveability, Emissions, and Electrical Diagnosis Manual.

8C-6 INSTRUMENT PANEL AND GAGES



- | | |
|--|---|
| 131. CONNECTORS, RADIO | 147. CONNECTOR, REAR SPEAKER HARNESS |
| 132. RADIO | 148. CONVENIENCE CENTER |
| 133. CONNECTOR, INSTRUMENT CLUSTER | 149. CONNECTOR, SEAT BELT |
| 134. CONNECTOR, DIMMER SWITCH | 150. CONNECTOR, MANUAL TRANSMISSION |
| 135. SWITCH, DIMMER | 151. ASSEMBLY, AMPLIFIER |
| 136. SWITCH, HEADLAMP | 152. CONNECTOR, CIGAR LIGHTER |
| 137. CONNECTOR, HEADLAMP SWITCH | 153. LIGHTER, CIGAR |
| 138. HARNESS, HEADLAMP | 154. CONNECTOR, LOW COOLANT INDICATOR |
| 139. CONNECTOR, SPEAKER | 155. CONNECTOR, A/C, HEATER |
| 140. CONNECTOR, DOOR JAMB SWITCH | 156. CONNECTORS, ENGINE HARNESS |
| 141. SWITCH, DOOR JAMB | 157. CONNECTOR, DOOR JAMB SWITCH |
| 142. RELAY, DAYTIME RUNNING LAMP | 158. SWITCH, DOOR JAMB |
| 143. FLASHER, HAZARD | 159. CONNECTOR, SPEAKER |
| 144. CONNECTOR, HAZARD FLASHER | 160. CONNECTOR, VEHICLE SPEED CALIBRATOR MODULE |
| 145. CONNECTOR, DAYTIME RUNNING LAMP RELAY | 161. VEHICLE SPEED CALIBRATOR MODULE |
| 146. CONNECTOR, PARK BRAKE SWITCH | |

3108r5362

Figure 5—Instrument Panel Harness

DIAGNOSIS OF THE SPEEDOMETER AND VEHICLE SPEED SENSOR CALIBRATOR

PROBLEM	POSSIBLE CAUSE	CORRECTION
Speedometer and Odometer are Inaccurate	Incorrect vehicle speed sensor calibrator.	Install correct vehicle speed sensor calibrator.
Speedometer And Odometer Do Not Operate Properly	1. Inoperative vehicle speed sensor calibrator. 2. Poor ground path from the vehicle speed sensor calibrator. 3. No signal from the vehicle speed sensor. 4. Inoperative vehicle speed sensor calibrator (speedometer output). 5. Inoperative vehicle speed sensor calibrator (cruise output). 6. Inoperative instrument cluster.	1. Disconnect the vehicle speed sensor calibrator, and place the ignition in "RUN". Check for voltage between the PNK/BLK wire in the harness and a good chassis ground. If the voltage is less than the battery voltage, check for an open or short in the PNK/BLK wire. 2. Check for voltage between the PNK/BLK wire in the harness and the BLK/WHT wire. If the voltage is less than battery voltage, check for an open or short in the BLK/WHT wire. 3. Raise and support the vehicle, start the engine, and place the transmission in drive. Check for AC voltage that varies with engine rpm between the PPL/WHT wire, and the LT GRN/BLK wire at the vehicle speed sensor calibrator. If there is not AC voltage at these wires, check for opens in the PPL/WHT wire and the LT GRN wire. If there are not shorts or opens, replace the vehicle speed sensor. 4. Raise and support the vehicle, start the engine, and place the transmission in drive. Check for AC voltage that varies with engine RPM, between the BLU/BLK and BLK/WHT wires at the vehicle speed sensor connector (connector attached to calibrator). If AC voltage varies with RPM, replace the vehicle speed sensor calibrator. 5. Raise and support the vehicle, start the engine, and place the transmission in drive. Check for AC voltage that varies with engine rpm between the RED/WHT and the BLK/WHT wires at the vehicle speed sensor calibrator connector (connector attached). If AC voltage varies with rpm, replace the vehicle speed sensor calibrator. 6. Replace Cluster.

D0268

8C-8 INSTRUMENT PANEL AND GAGES

DIAGNOSIS OF THE FUEL GAGE

PROBLEM	POSSIBLE CAUSE	CORRECTION
Gage Stays at Empty	1. No fuel. 2. Circuit is grounded.	1. Fill the fuel tank. 2. Disconnect the lead at the fuel tank. Place the ignition in "RUN". The gage should read past the full mark. If the gage reads past the full mark, replace the fuel tank sender. If the gage stays at the empty mark, find the ground in the circuit between the gage and the fuel tank.
Gage Stays at Full or Beyond	Open circuit between the gage and the sender.	Disconnect the sender lead at the fuel tank. Ground the lead. Place the ignition in "RUN". The fuel gage should read at the empty mark. If the gage reads at the empty mark, replace the sender. If the gage still reads at full or beyond, find the open between the gage and the fuel tank.
Gage Reads Wrong	1. Corrosion or a loose connection. 2. Sender. 3. Gage.	1. Clean and tighten the terminals. 2. Remove the sender. Test the sender with an ohmmeter. The empty position should read between 0 and 3 ohms. The one-half full position should read 44 ohms. The full position should read between 88 and 92 ohms. 3. Disconnect the front body connector. Connect J 33431-A tester to the lead that goes to the gage. Turn the engine control switch "ON". If the gage responds accurately, check the wiring between the rear compartment and the front body connector. If the gage reads between one fourth and one half with the J 33431-A set at 90 ohms, replace the cluster.
D0152		

DIAGNOSIS OF THE COOLANT TEMPERATURE GAGE

PROBLEM	POSSIBLE CAUSE	CORRECTION
Gage Does Not Move from "Cold" when the Engine is "Hot"	1. Blown fuse. 2. Sensor. 3. Open circuit.	1. Check fuse and replace if blown. If the gage does not work, turn ignition switch "OFF." Check for continuity between the sensor wire at the gage to ground, and between the ignition terminal and ground. If all checks "OK," replace the cluster. 2. Turn ignition switch "ON." Do not start engine. Remove the lead at the sensor. Connect the test lamp from the sensor lead to ground. If the lamp glows, then short the sensor lead to ground. Gage should indicate "HOT." If the gage indicates "HOT," check the sensor lead connector on the sensor. If OK, replace the sensor. If the gage indicates "COLD" check the cluster connector. If OK, remove the cluster for repair. 3. If the test lamp does not glow, turn ignition switch "OFF." Check for continuity between the sensor wire at the gage and ground, and between the ignition terminal and ground. If all checks "OK," replace the cluster.
Gage Indicates "Hot" with Cold Engine	Shorted or grounded circuit.	Turn ignition switch "ON." Remove the lead at the sensor. The gage should swing to "COLD." If not, check the harness for shorts or grounds. If the harness is not grounded and the needle still indicates "HOT," disconnect the cluster from the harness connector. If the needle indicates "COLD," repair the grounded harness. If the needle indicates "HOT," repair the instrument cluster.
Gage Reads Low	1. Determine if problem is engine or gage related. 2. Resistance in the circuit due to corrosion or a loose connection. 3. Sensor.	1. Connect a scan tool and read engine coolant temperature. Do the scan tool and temperature gage agree? If so, correct the engine problem. If not, proceed to step 2. 2. Clean and tighten the terminals and connections in the circuit. Check for resistance in the ground path of the sensor. 3. Remove the lead at the sensor. Measure the resistance with an ohmmeter. At 40°C (104°F) the resistance is about 1300 ohms. At 95°C (203°F) resistance is about 220 ohms, plus/minus 20. If the sensor does not have approximately these values, replace the sensor.
Gage Reads High	1. Sensor. 2. Circuit has a high resistance ground.	1. Measure the sensor's resistance as described in the previous step. 2. Disconnect the sensor lead at the gage and sensor. Check for a high resistance ground with an ohmmeter. Repair the circuit as necessary.

DIAGNOSIS OF THE OIL PRESSURE GAGE

PROBLEM	POSSIBLE CAUSE	CORRECTION
Gage Reads at 0	1. Low oil level. 2. The circuit is grounded between the gage and the sensor. 3. Sensor.	1. Check oil level. Add oil if necessary. Refer to Section 6. 2. Remove the sensor lead at the sensor. The gage should read "80." If the gage stays at "0", remove the sensor lead at the gage. The gage should read "80." If the gage reads "80", find the ground in the circuit between the gage and the sensor. If the gage reads "0", replace the cluster. 3. Remove the sensor lead at the sensor. Connect an ohmmeter to the sensor. With the engine stopped, the resistance should be one ohm. With the engine running, the resistance should be about 44 ohms at 40 psi (275 kPa). If the sensor reads one ohm with the engine running, replace the sensor.
Gage Reads 80 or Above	The sensor circuit has an open.	Disconnect the sensor lead from the sensor. Ground the sensor lead. The gage should read "0" psi. If the gage reads "0" psi, replace the sensor. If the gage stays at "80" psi, find the open in the circuit between the gage and the sensor.
Gage Readings are in Error	Gage.	Remove the sensor lead from the sensor. Connect the J 33431-A Tester to the sensor lead and ground. If the gage responds accurately to the tester, replace the sensor. If the gage does not respond accurately to the tester, replace the cluster.
Gage Readings are Delayed on Cold Start	Normal condition on 4 wheel drive diesel vehicles.	Following a diesel engine start on 4 wheel drive models that have not run for 2 hours or more, a few seconds (5-10) may elapse before the oil pressure gage indicates oil pressure. This is a normal condition.
D0154		

DIAGNOSIS OF THE VOLTMETER

PROBLEM	POSSIBLE CAUSE	CORRECTION
Voltmeter Reads at Bottom of the Red Band	1. Discharged battery. 2. High resistance in the voltmeter connections. 3. Voltmeter.	1. Measure the voltage across the battery. Recharge the battery. Read the instrument cluster voltmeter with the charger working. The voltage should come up to at least above the top of the lower red band. Find and correct the cause of the battery discharging. 2. Clean and tighten the connections. 3. Apply 12 volts across the ignition and ground leads. If the voltmeter doesn't read above the lower red band, replace the cluster.
D0155		

DIAGNOSIS OF THE BRAKE WARNING SYSTEM

PROBLEM	POSSIBLE CAUSE	CORRECTION
Warning Lamp Won't Light During Bulb Check	1. Lamp bulb is burned out. 2. Open in the circuit.	1. Replace the bulb. 2. Remove the switch lead at the switch. Refer to Section 5. Ground the switch lead with a jumper. Turn ignition switch "ON." If the lamp comes on, test the switch. Refer to Section 5. If the switch is bad, replace it. Refer to Section 5.
D0158		

DIAGNOSIS OF THE "CHECK GAGES" LAMP

PROBLEM	POSSIBLE CAUSE	CORRECTION
"Check Gages" Telltale Lamp Does Not Light With High Temperature	1. Burned out bulb. 2. Inoperative check gages circuit.	1. Replace "Check Gages" telltale bulb. 2. Replace cluster.
"Check Gages" Telltale Lamp Does Not Light With Low Oil Pressure	1. Burned out bulb. 2. Inoperative check gages circuit.	1. Replace "Check Gages" telltale bulb. 2. Replace cluster.
Check Gages Telltale Lights at All Times	1. Verify temperature gage circuit works correctly. 2. Verify oil pressure gage circuit works correctly.	1. Replace cluster. 2. Replace cluster.
D0269		

ON-VEHICLE SERVICE

ELECTROSTATIC DISCHARGE (ESD) NOTICE

Many solid state electrical components can be damaged by electrostatic discharge (ESD). Some will display a label but many will not (figure 6).

NOTICE: In order to avoid possibly damaging any components, observe the following:



Figure 6—Electrostatic Discharge Label

1. Body movement produces an electrostatic charge. To discharge personal static electricity, touch a ground point (metal) on the vehicle. This should be done any time you:
 - Slide across the vehicles seat.
 - Sit down or get up.
 - Do any walking.
2. Do not touch exposed terminals on components with your finger or any tools. Remember, the connector that you are checking might be tied into a circuit that could be damaged by Electrostatic Discharge.
3. When using a screwdriver or similar tool to disconnect a connector, never let the tool come in contact with or come between the exposed terminals.
4. Never jump, ground, or use test equipment probes on any components or connectors unless specified in diagnosis. When using test equipment, always connect the ground lead first.
5. Do not remove the solid state component from its protective packaging until you are ready to install the part.

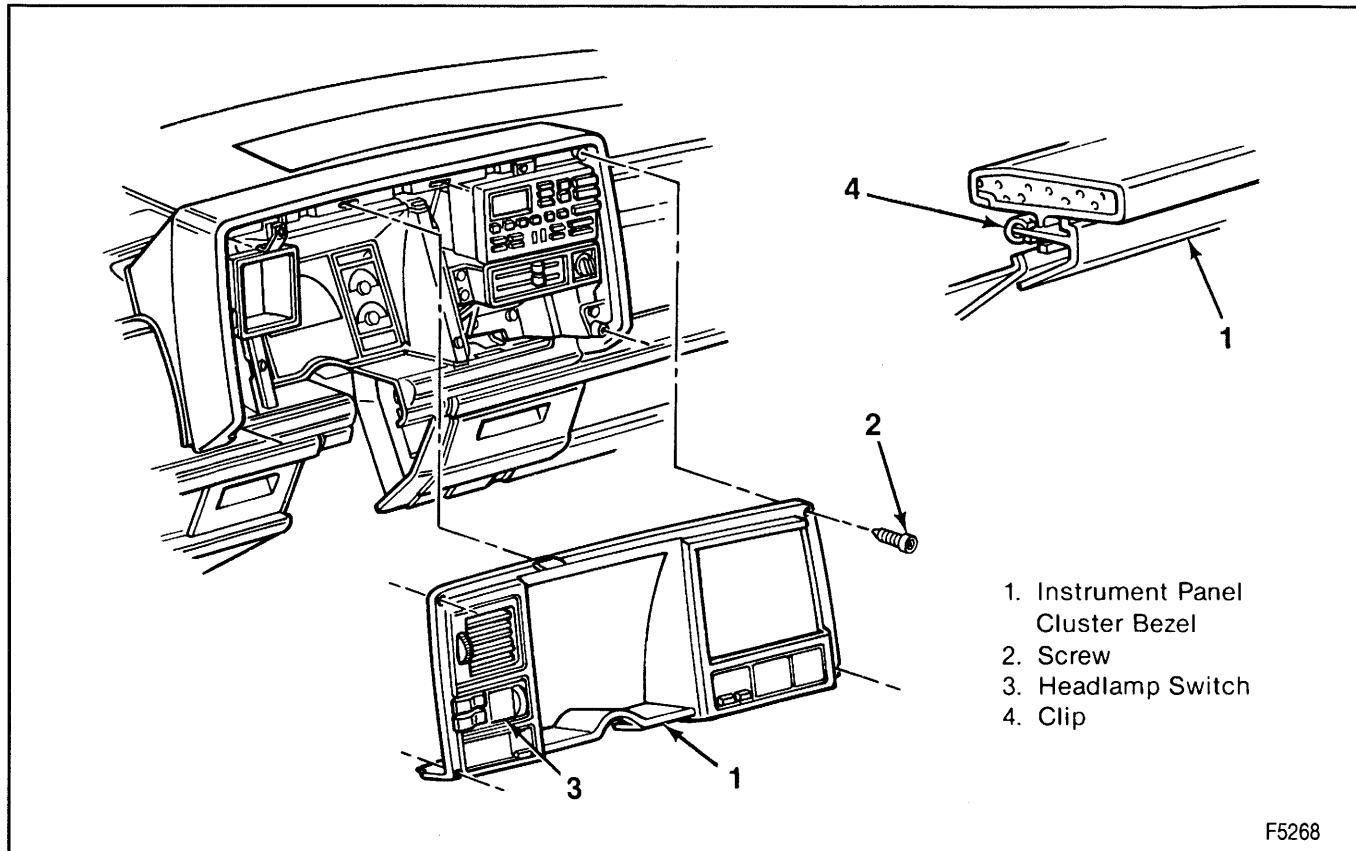


Figure 7—Instrument Cluster Bezel

6. Always touch the solid state components package to a ground before opening. Solid state components can also be damaged if:

- They are bumped or dropped.
- They are laid on any metal work benches or components that operate electrically, such as a TV, radio, or oscilloscope.

INSTRUMENT CLUSTER AND INDICATOR LAMP REPLACEMENT

! Important

- If the instrument cluster is to be sent out for repair, exchange, or is being replaced, note the number and type of bulb and socket assemblies before proceeding. Due to the variety of optional equipment available, replacement clusters do not always have the correct number or type of indicator lamps. Comparing bulb locations beforehand will ensure that all indicator lamps remain functional.

↔ Remove or Disconnect (Figures 7, 8, and 9)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel cluster bezel.
 - Electrical connections for headlamp switch, dimmer control, and any accessory switches.
3. Six screws holding the radio control head.
 - Disconnect the harness and antenna connectors and set the control head aside.

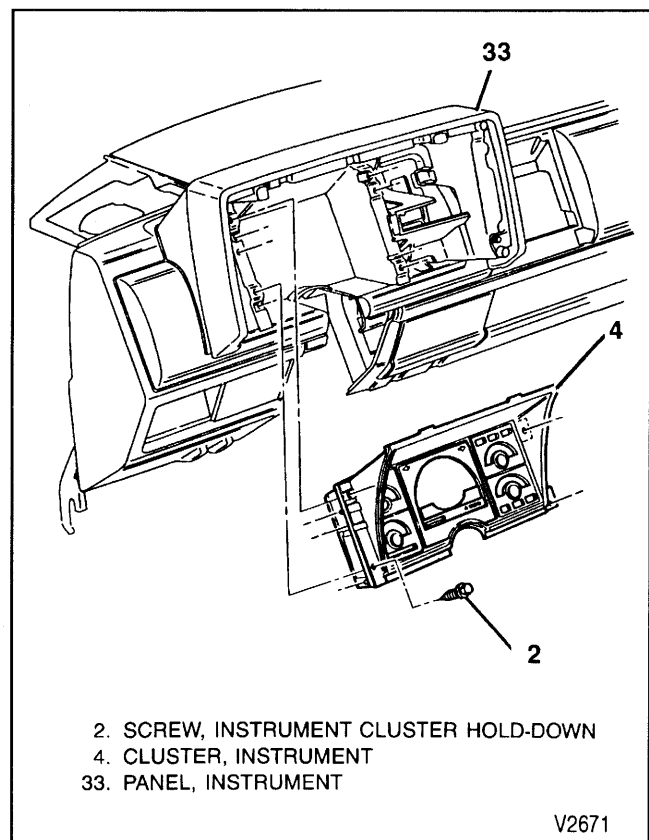


Figure 8—Instrument Cluster Replacement

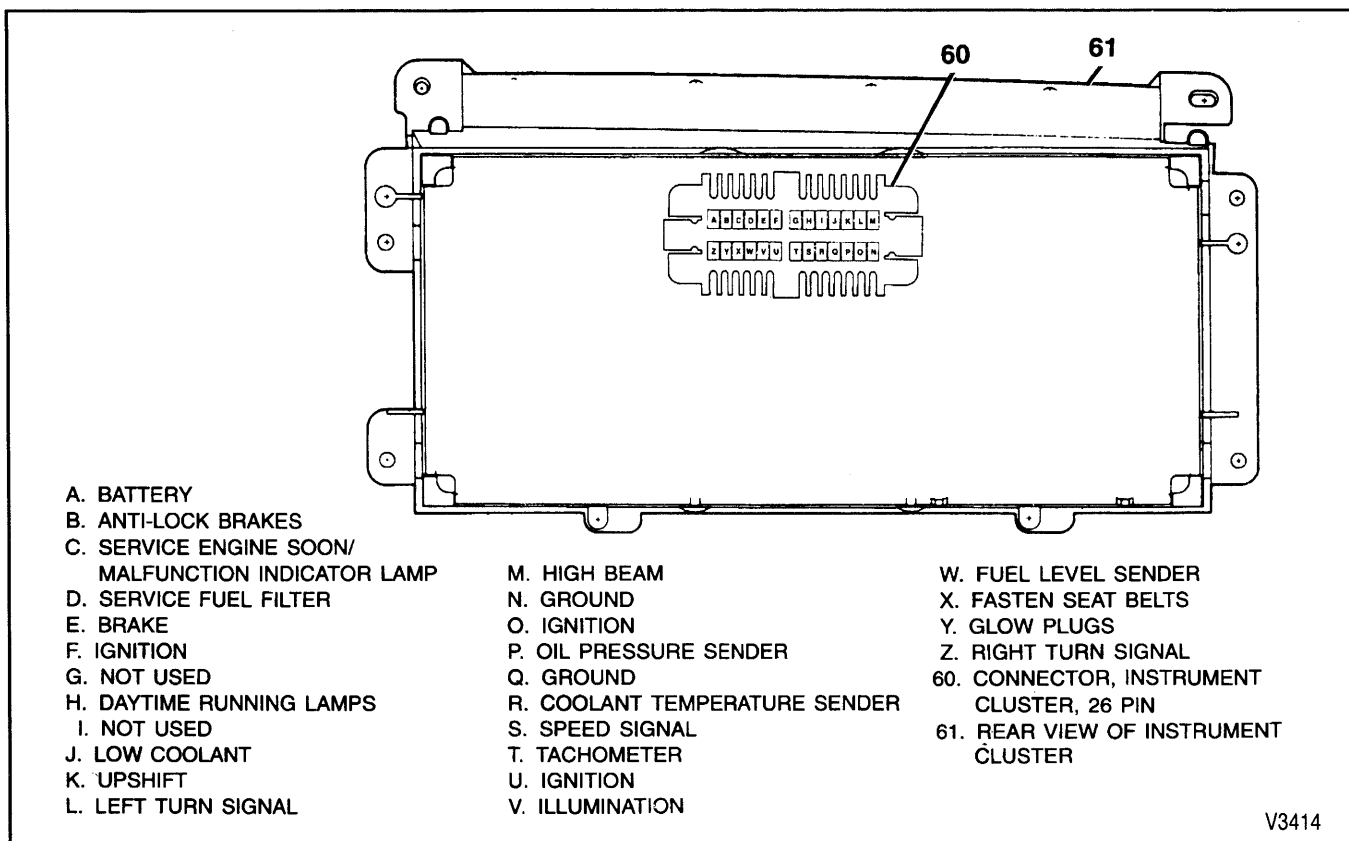


Figure 9—Instrument Cluster 26 PIN Connector

4. Four screws holding the heater control unit and set aside.
 - For air conditioned vehicles, disconnect the A/C harness.
5. Instrument cluster hold-down screws.
6. Gear shift indicator cable from the steering column lower shift bowl.

NOTICE: Refer to ESD "Notice."

7. Instrument cluster.
 - Keep fingers and other foreign objects away from the flexible circuit connections.
8. Bulb and base assembly by turning 1/2 turn to the left. Refer to SECTION 8B for bulb identification.

→← Install or Connect (Figures 7, 8, and 9)

NOTICE: Refer to ESD "Notice."

1. Bulbs to the cluster by inserting the socket and bulb assembly into the cluster and twisting to the right.
2. Instrument cluster.

NOTICE: Refer to "Notice" on page 8C-1.

3. Instrument cluster hold-down screws.
4. Gear shift indicator cable to the lower shift bowl of the steering column (if equipped). Refer to "Transmission Indicator (PRNDL) Replacement" for adjustment sequence.

5. Radio and heater control units.
 - Electrical connections as required.
6. Instrument cluster bezel.
 - Reconnect headlamp switch and dimmer controls.
7. Negative battery cable.

TRANSMISSION INDICATOR (PRNDL) REPLACEMENT

↔ Remove or Disconnect

NOTICE: Refer to ESD "Notice."

1. Instrument cluster. Refer to "Instrument Cluster Replacement."
2. Cluster lens.
3. Transmission indicator assembly.

→← Install or Connect

1. Indicator assembly to instrument cluster.
2. Instrument cluster lens.
3. Instrument cluster to the vehicle.

🔧 Adjust Shift Indicator

4. Indicator cable to the lower shift bowl.
 - A. Set the parking brake.
 - B. Place the transmission in neutral.

8C-14 INSTRUMENT PANEL AND GAGES

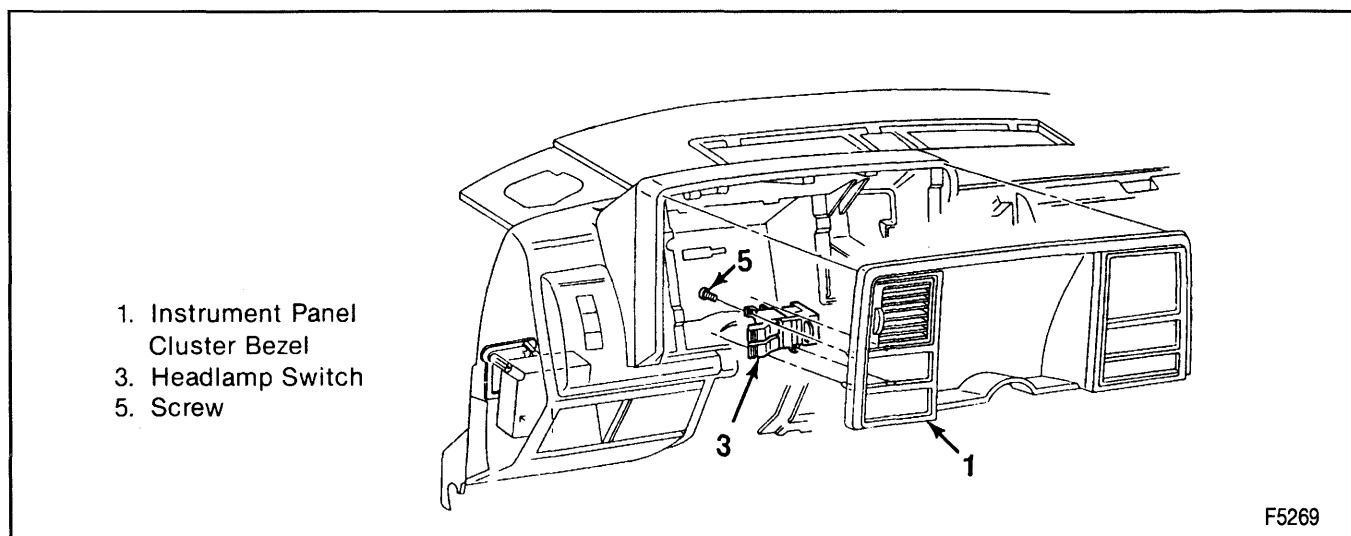


Figure 10—Headlamp Switch

- C. Pull the cable until the needle is aligned with neutral on the indicator.
- D. Attach the cable clip to the lower shift bowl in this position.
- 5. Instrument cluster to the vehicle. Refer to "Instrument Cluster Replacement."

INSTRUMENT CLUSTER BEZEL AND HEADLAMP SWITCH REPLACEMENT

↔ Remove or Disconnect (Figures 7 and 10)

- 1. Screws.
- 2. Instrument cluster bezel.
 - Pull the bezel away from the instrument panel clips.
- 3. Headlamp switch screws.
- 4. Headlamp switch from the bezel.

→← Install or Connect (Figures 7 and 10)

- 1. Headlamp switch to the bezel.

- 2. Headlamp switch screws.
- 3. Instrument cluster bezel clips to the bezel.
- 4. Instrument cluster bezel to the instrument panel.
- 5. Instrument cluster bezel screws.

VEHICLE SPEED SENSOR CALIBRATOR REPLACEMENT

↔ Remove or Disconnect (Figure 11)

- 1. Negative battery cable. Refer to SECTION 0A.
- 2. Instrument panel storage compartment inner panel.
- 3. Vehicle speed sensor calibrator from the fastener pad.
- 4. Electrical connectors from the vehicle speed sensor calibrator.

→← Install or Connect (Figure 11)

- 1. Electrical connectors to the vehicle speed sensor calibrator.

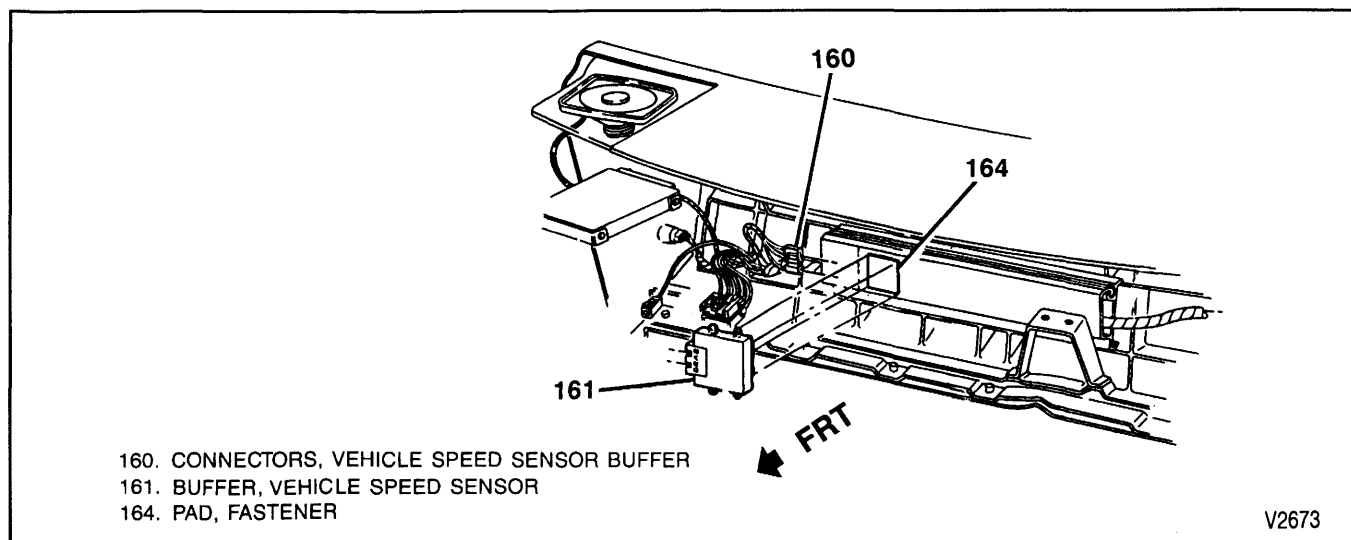


Figure 11—Vehicle Speed Sensor Calibrator (Buffer) Replacement

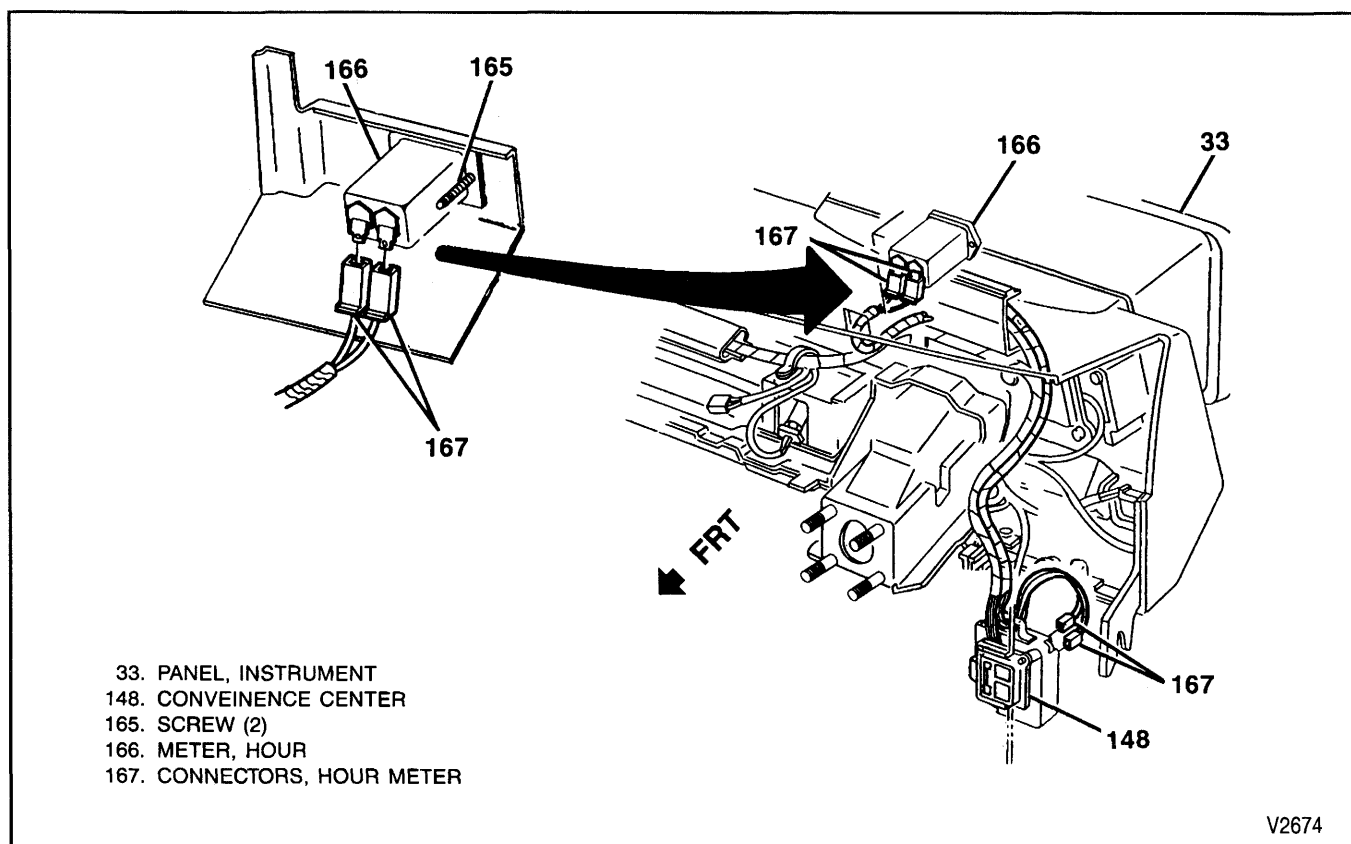


Figure 12—Hour Meter Replacement and Wiring Harness

2. Vehicle speed sensor calibrator to the fastener pad.
3. Instrument panel storage compartment inner panel.
4. Negative battery cable.

HOURLY METER REPLACEMENT

Remove or Disconnect (Figure 12)

1. Negative battery cable. Refer to SECTION 0A.
2. Screws.
3. Hour meter from the instrument panel.
4. Electrical connections from the hour meter.

Install or Connect (Figure 12)

1. Electrical connections to the hour meter.
2. Hour meter to the instrument panel.
3. Screws.
4. Negative battery cable.

COOLANT TEMPERATURE SENSOR REPLACEMENT

Remove or Disconnect (Figures 13 through 16)

1. Negative battery cable. Refer to SECTION 0A.
2. Coolant. Refer to SECTION 6B1.
3. Electrical connector.
4. Sensor.

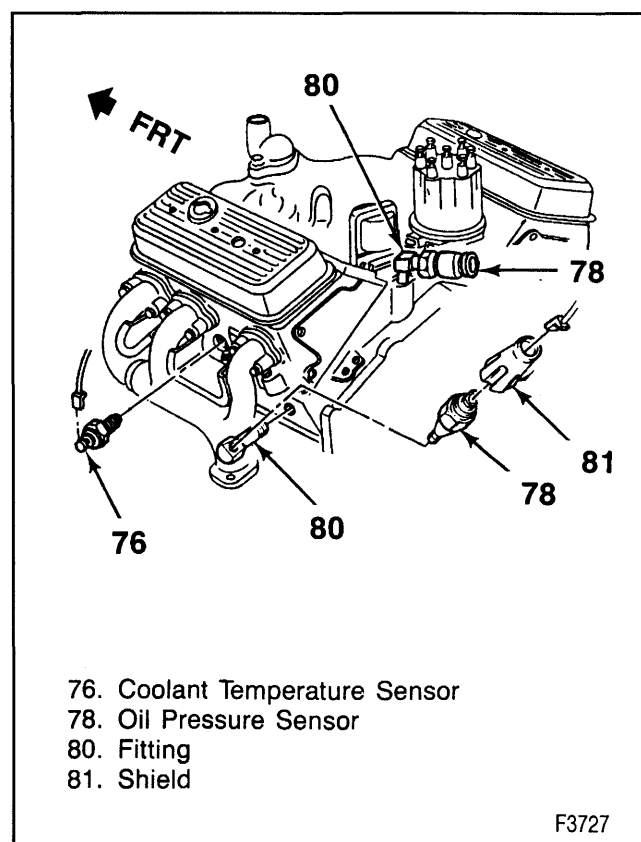


Figure 13—Coolant Temperature and Oil Pressure Sensors (4.3L VIN Z)

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Install or Connect (Figures 13 through 16)

1. Sensor.
2. Electrical connector.
3. Coolant. Refer to SECTION 6B1.
4. Negative battery cable.

OIL PRESSURE SENSOR REPLACEMENT

Remove or Disconnect (Figures 13 through 16)

Tool Required:
J 35749 Socket

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connector.
3. Sensor using J 35749.

Install or Connect (Figures 13 through 16)

Tool Required:
J 35749 Socket

1. Sensor using J 35749.
2. Electrical connector.
3. Negative battery cable.

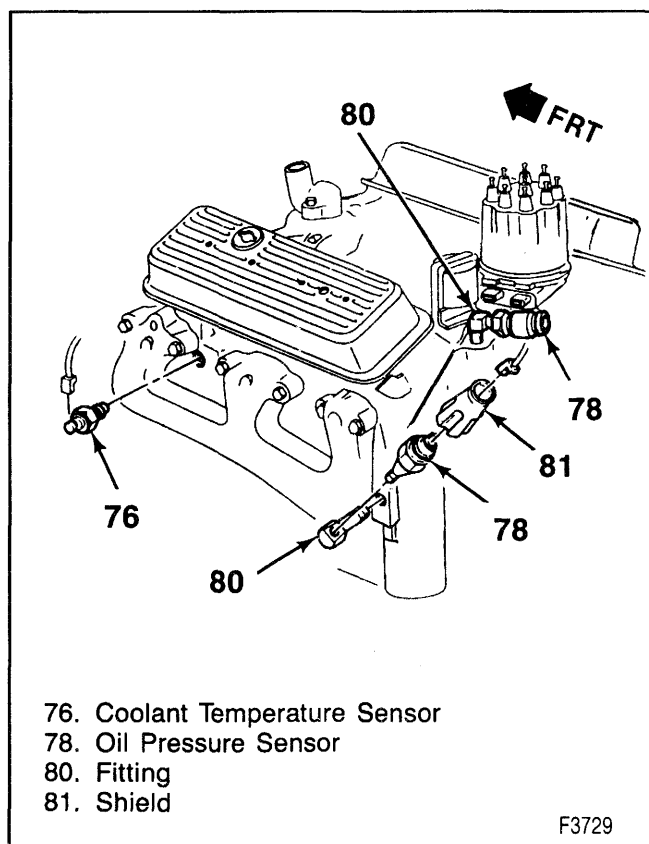


Figure 14—Coolant Temperature and Oil Pressure Sensors (5.0L VIN H and 5.7L VIN K)

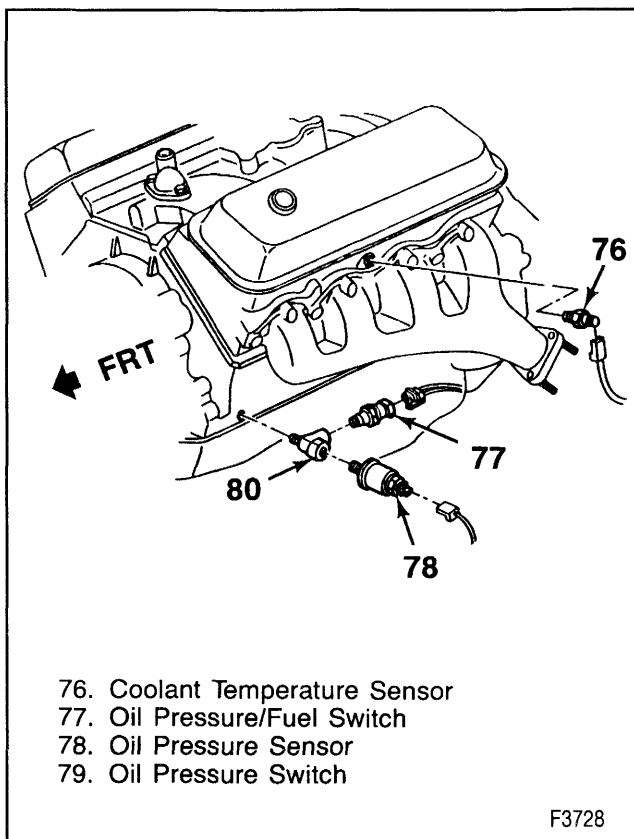


Figure 15—Coolant Temperature and Oil Pressure Sensors (7.4L VIN N)

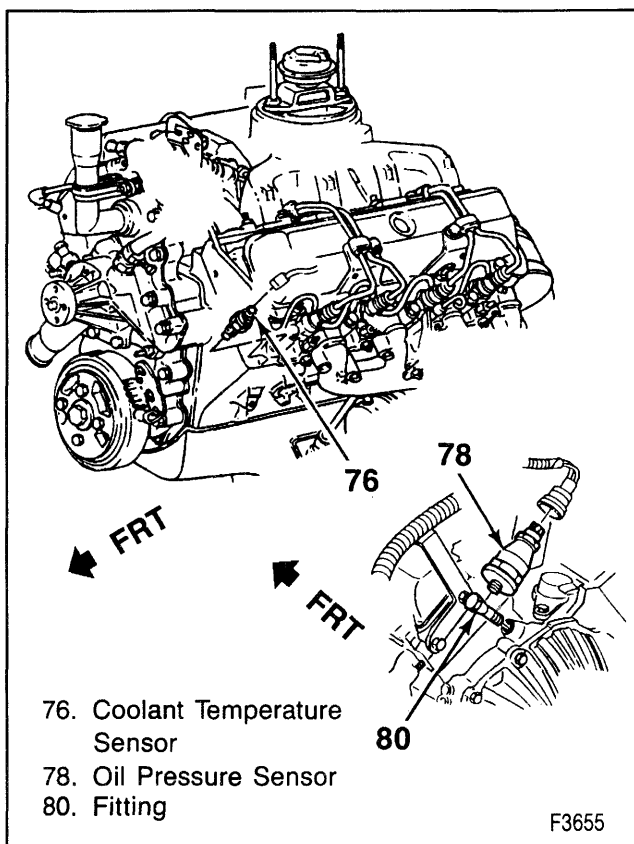


Figure 16—Coolant Temperature and Oil Pressure Sensors (6.5L VIN P, S, and F)

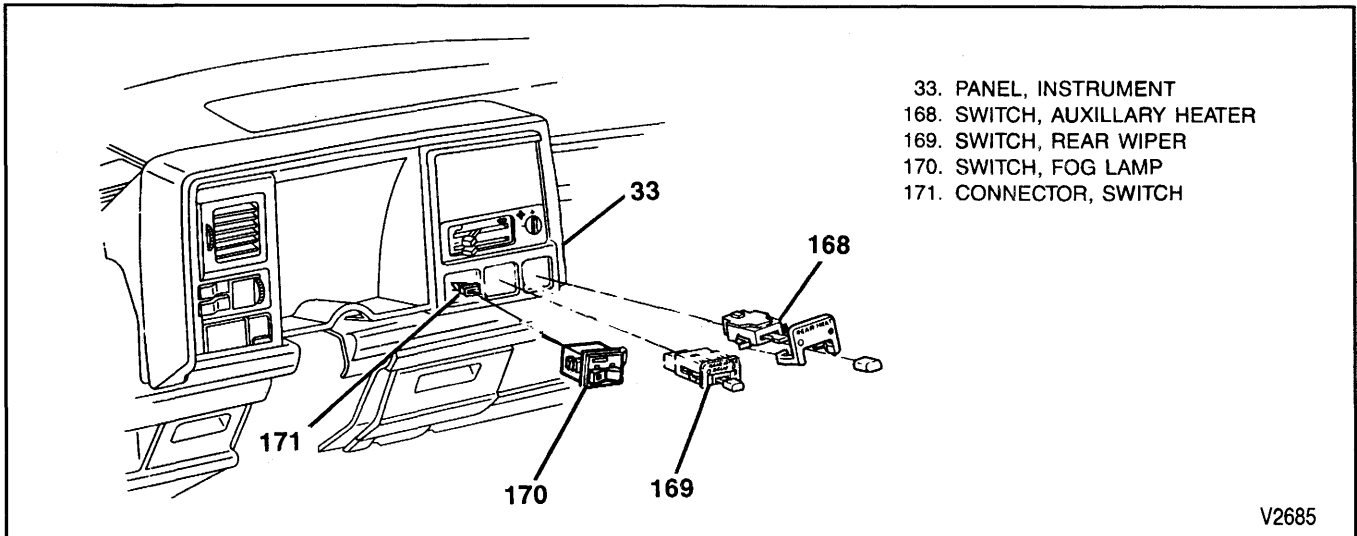


Figure 17—Accessory Switch Replacement

ACCESSORY SWITCH REPLACEMENT

Remove or Disconnect (Figures 7 and 17)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel cluster bezel. Refer to figure 7.
3. Electrical connector.
4. Switch (168, 169, or 170) from the bezel.

Install or Connect (Figures 7 and 17)

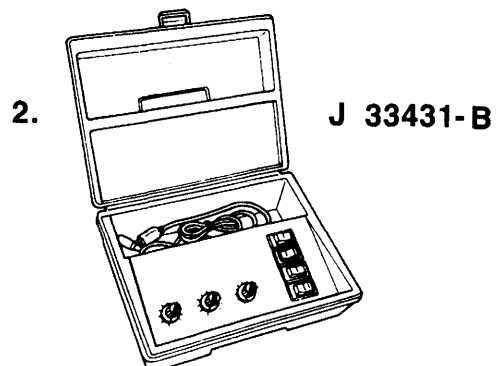
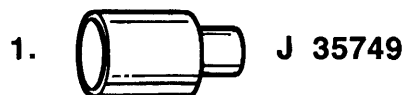
1. Switch (168, 169, or 170) to the bezel.
2. Electrical connector.
3. Instrument panel cluster bezel. Refer to figure 7.
4. Negative battery cable.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	In. Lbs.
Vehicle Speed Sensor Bolt.....	11	97
		T2846

SPECIAL TOOLS



1. Oil Pressure Sending Unit Socket
2. Signal Generator and Instrument Panel Tester

NOTES

SECTION 8D

CHASSIS ELECTRICAL

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Snow Plow Relay Location	8D-2
Diagnosis of the Horn System	8D-3
On-Vehicle Service	8D-4
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GENERAL DESCRIPTION

HORN SYSTEM

The horn system starts at the fuse block with the horn/dome fuse. The circuit goes from the fuse block to the horn relay. At the horn relay, the circuit splits; one branch goes through the relay coil to the horn switch in the steering column, and the other goes through the relay contacts to the horn.

When the horn switch is closed, it provides a ground path for the horn relay coil. Current flows into the relay coil, closing the contacts, then to the horn, creating an appropriate sound.

The horn relay is located in the convenience center located under the instrument panel on the left side of the steering column (figure 1).

CAMPER AND TRAILER WIRING

Two trailer harnesses are available: heavy-duty trailer towing (UY7) and camper (UY1).

Option UY7 trailer harness is for heavy-duty towing applications. A 30-amp fused battery feed wire and auxiliary circuit routes from the cowl-mounted junction block, along the body side rail, to the rear bumper crossmember. The harness for the brake/parking lamps is spliced from the rear lamp harness. The harness is located at the rear bumper crossmember and is bound with a plastic strap. The wiring harness is wrapped with tape to prevent short circuits.

The function of the seven wires are:

1. Red—30-amp fused battery feed.
2. Dark Blue—An auxiliary circuit.
3. Brown—Tail and license lamps.
4. Light Green—Backup lamps.
5. Dark Green—Right turn signal and stoplamp.
6. Yellow—Left turn signal and stoplamp.
7. White—Ground.

This option does not include a connector at the end of the harness and must be wired after production by a qualified service person.

Attach the trailer harness wiring to the trailer and then strap it to the vehicle frame rail in such a way that enough slack is left in the harness to prevent bending, binding, or breakage of the wiring. Do not allow the harness to drag on the ground. Tape or strap the trailer portion of the harness (if used) to the tongue of the trailer. This will prevent the harness from dragging on the ground.

When the wiring is not being used, wrap the harness together and bind it with a tie strap to keep it from being damaged. Store the harness behind the rear bumper on the fuel tank strap with a band or tie strap.

The second wiring harness option is the UY1 camper wiring harness, and is also spliced from the rear lamp harness.

This harness is for the brake/parking lamps and an auxiliary power feed. The harness is located in the front stake pocket during production and is wrapped and

8D-2 CHASSIS ELECTRICAL

bound with a plastic strap. This option uses a single harness and a connector using five wires (figures 2 and 3).

The function of the wires are:

1. Dark Blue—A 30-amp fused auxiliary power circuit. The other end of this wire is taped to the wiring near the junction block on the cowl.
2. Dark Green—Right turn signal and stoplamp.
3. Yellow—Left turn signal and stoplamp.
4. Brown—Tail lamps.
5. White—Ground.

Route the trailer harness wiring between the frame and bumper, or camper and body, in such a way that enough slack is left in the harness to prevent bending, binding, or breakage of the wiring. Do not allow the harness to drag. Tape or strap the trailer portion of the harness (if used) to the vehicle. This will prevent the harness from dragging.

When the wiring is not being used, wrap the harness together and bind it with a tie strap to keep it from being damaged.

SNOW PLOW RELAY LOCATION

Some vehicles are equipped with option VYU. This means the vehicle has been prepared for an optional snow plow. A vehicle with this option has two relays mounted on the radiator support. These relays are for optional equipment that may be installed when using a snow plow.

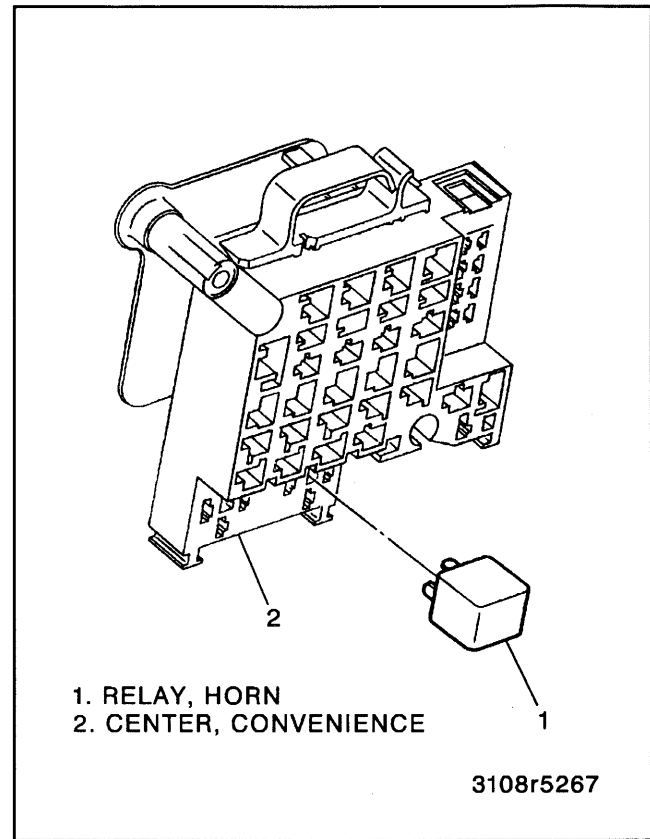


Figure 1—Horn Relay

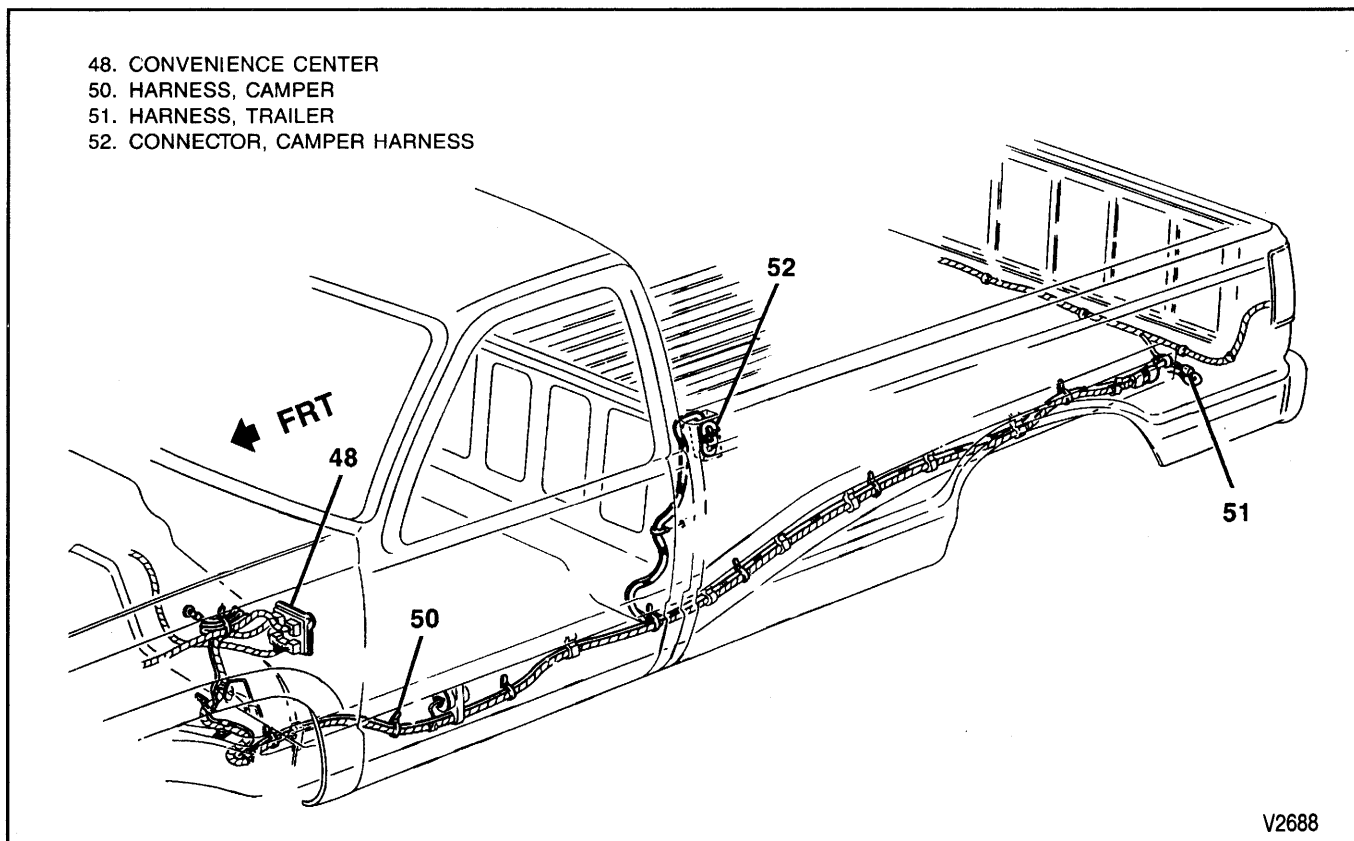


Figure 2—Camper Harness Routing

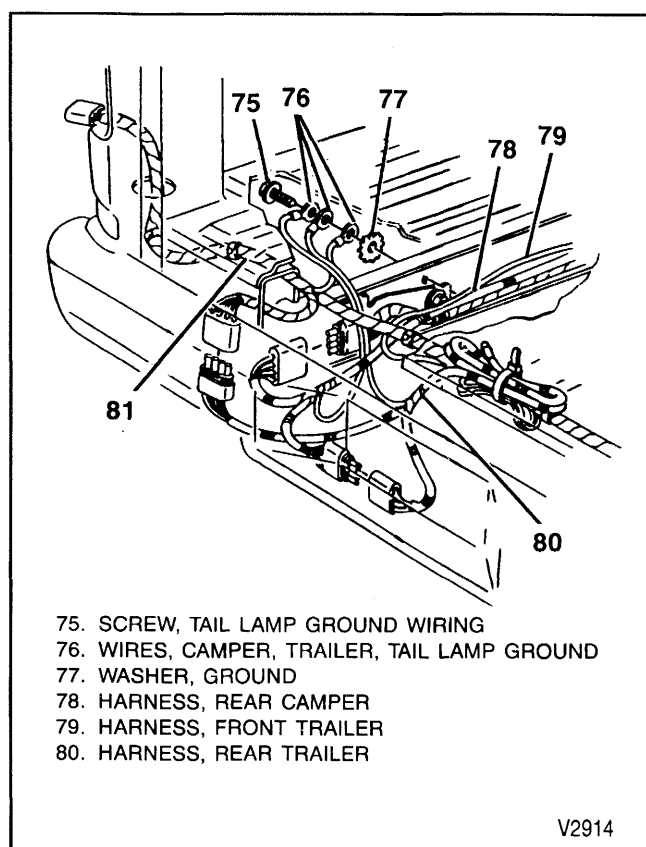


Figure 3—Trailer Harness Routing

DIAGNOSIS OF THE HORN SYSTEM

PROBLEM	POSSIBLE CAUSE	CORRECTION
Horn Won't Blow, Interior Lights Inop- erative	1. HORN/DOME lamp fuse blown.	1. Check HORN/DOME lamp fuse. Replace as necessary. If the new fuse blows, repair short to ground in the ORN/BLK wire from the fuse to the horn relay. If fuse blows when horn switch is depressed, repair short to ground in the GRN wire from the horn relay to the horn. If fuse continues to blow, check other circuits on HORN/DOME lamp fuse circuit for short to ground.

DIAGNOSIS OF THE HORN SYSTEM (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Horn Inoperative	1. Horn relay inoperative. 2. Open circuit.	1. Check for battery voltage at terminal #29 of the convenience center, relay installed, while depressing the horn switch. If battery voltage is present, then the relay is OK. If less than battery voltage and all other circuits are known to be good, replace the relay. 2. Check the ORN/BLK wire for an open circuit between the fuse block and the horn. Repair as necessary. Check DK GRN wire for an open circuit between the horn relay and the horn. Repair as necessary. Check the BLK wire and horn switch for an open circuit. Repair as necessary.
Horn Sounds Continuously	1. Horn switch contacts stuck in closed position. 2. Horn relay stuck in closed position. 3. Short to ground in DK GRN wire before the relay.	1. Replace horn switch. 2. Replace horn relay. 3. Find and repair short in DK GRN wire.

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ON-VEHICLE SERVICE**HORN REPLACEMENT****Remove or Disconnect (Figure 4)**

1. Negative battery cable. Refer to SECTION 0A.
2. Grille to radiator support filler panel for access (left horn only).
3. Connector.
4. Horn attaching bolt.
5. Horn from the vehicle.

**Install or Connect (Figure 4)**

1. Horn to the vehicle.

NOTICE: Refer to "Notice" on page 8D-1.

2. Bolt.

**Tighten**

- Horn bolt to 25 N.m (18 lbs. ft.).
3. Connector.
 4. Grille to radiator support filler panel (if removed).
 5. Negative battery cable.

SNOW PLOW RELAY REPLACEMENT**Remove or Disconnect (Figure 5)**

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connection from the relay.
3. Bolt.
4. Relay.

**Install or Connect (Figure 5)**

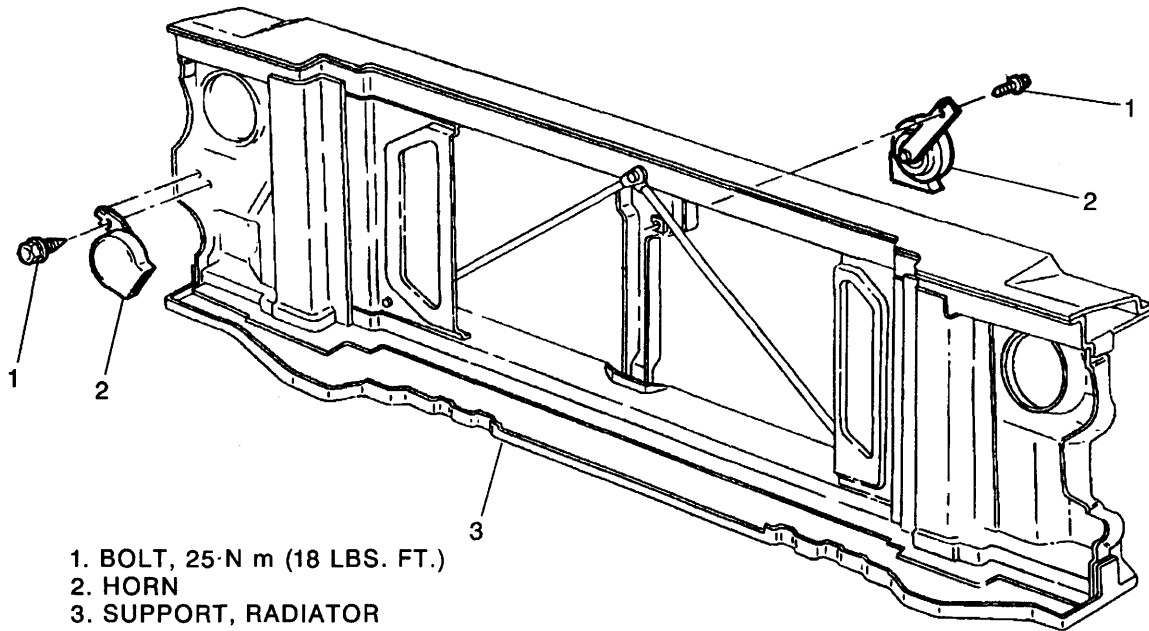
1. Relay.

NOTICE: Refer to "Notice" on page 8D-1.

2. Bolt.

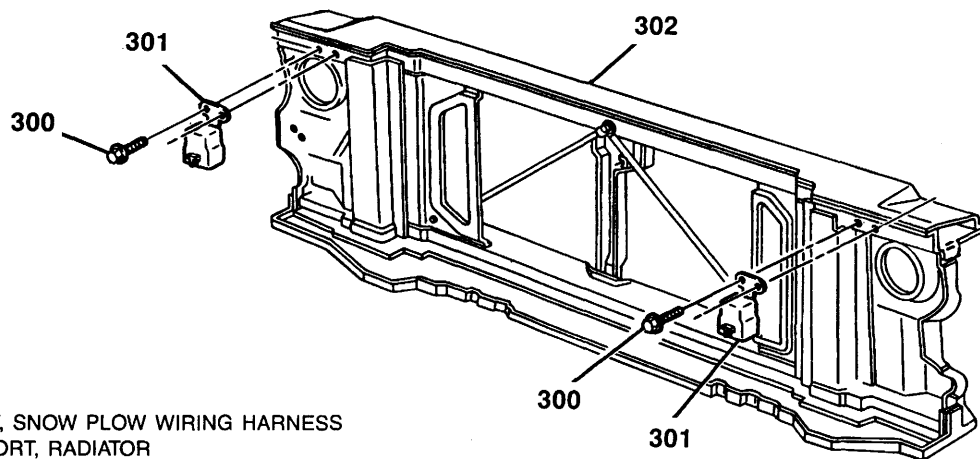
**Tighten**

- Snow plow relay bolt to 6 N.m (53 lbs. in.).
3. Electrical connection to the relay.
 4. Negative battery cable.



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Figure 4—Horn Replacement



V2686

Figure 5—Snow Plow Relay Replacement

SPECIFICATIONS
FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	In. Lbs.
Horn Attaching Bolt.....	25	18*
Snow Plow Relay Mounting Bolt.....	6	53
*Foot Pounds		
		T2859

SECTION 8E1**WINDSHIELD
WIPER/WASHER SYSTEM
(PULSE)**

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

WIPER/WASHER SYSTEM

The windshield wiper/washer system consists of a permanent magnet, positive-park wiper motor assembly (figure 1), a transmission assembly, wiper arm and blade assemblies, a washer pump mounted on the side of a washer solvent container, and a turn signal-type wiper/washer switch assembly with detents. The die-cast aluminum housing of the wiper motor provides

cooling for interior parts. The wiper motor is equipped with RFI (radio frequency interference) suppression.

The wiper motor drives a crank arm that attaches to individual transmission links for both the right and left sides. The transmission links are mounted in front of the windshield inside the fresh air plenum. The transmission transfers rotary motion from the wiper motor into reciprocating motion at the transmission drive shafts.

The wiper motor is sealed, and no service parts are available. The motor must be replaced and not repaired if service is required.

The delay module is also sealed and attached directly to the wiper motor. It is replaced as a unit during service.

WIPER/WASHER OPERATION

The electronic circuit board controls all the timing and washer commands (figure 2). When a wash button is pushed for more than 1 second, washer solvent is sprayed on the windshield as long as the button is held. This is accompanied by wiper activity that continues for about 6 seconds after the button is released.

Rotating the wiper switch to the "LO" or "HI" speed position closes the respective brush circuit and the wiper motor runs at that speed.

Rotating the wiper switch to the "DELAY" mode operates the wiper motor intermittently and the delay can be varied by rotating the switch back and forth.

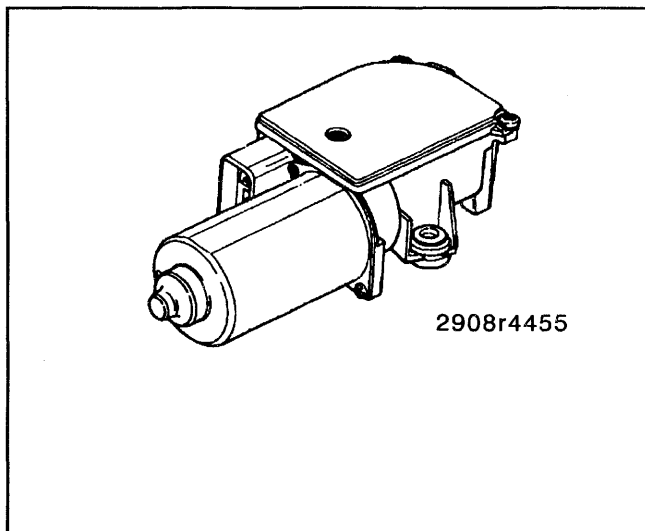


Figure 1—Wiper Motor Assembly

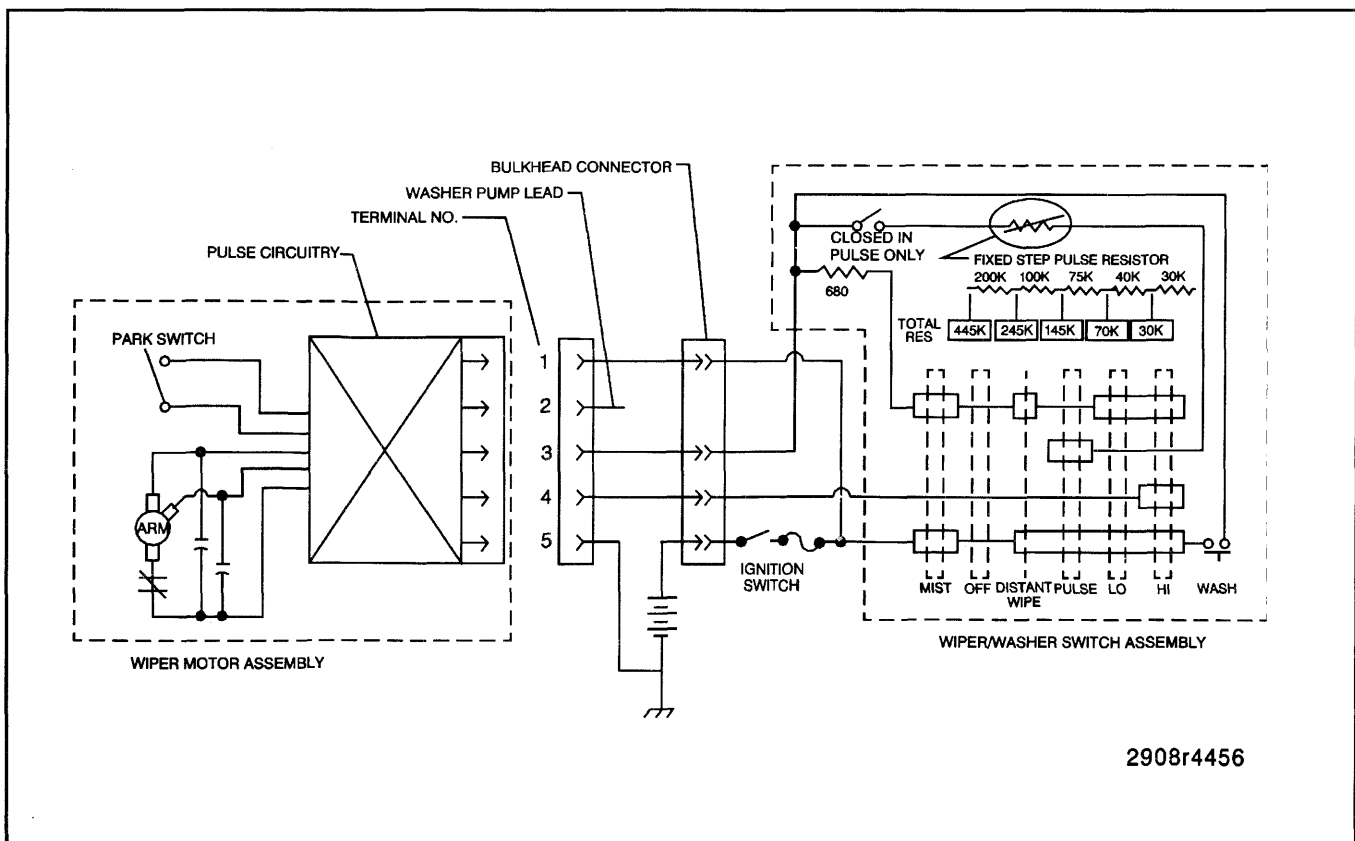


Figure 2—Wiper/Washer Motor Circuit Diagrams

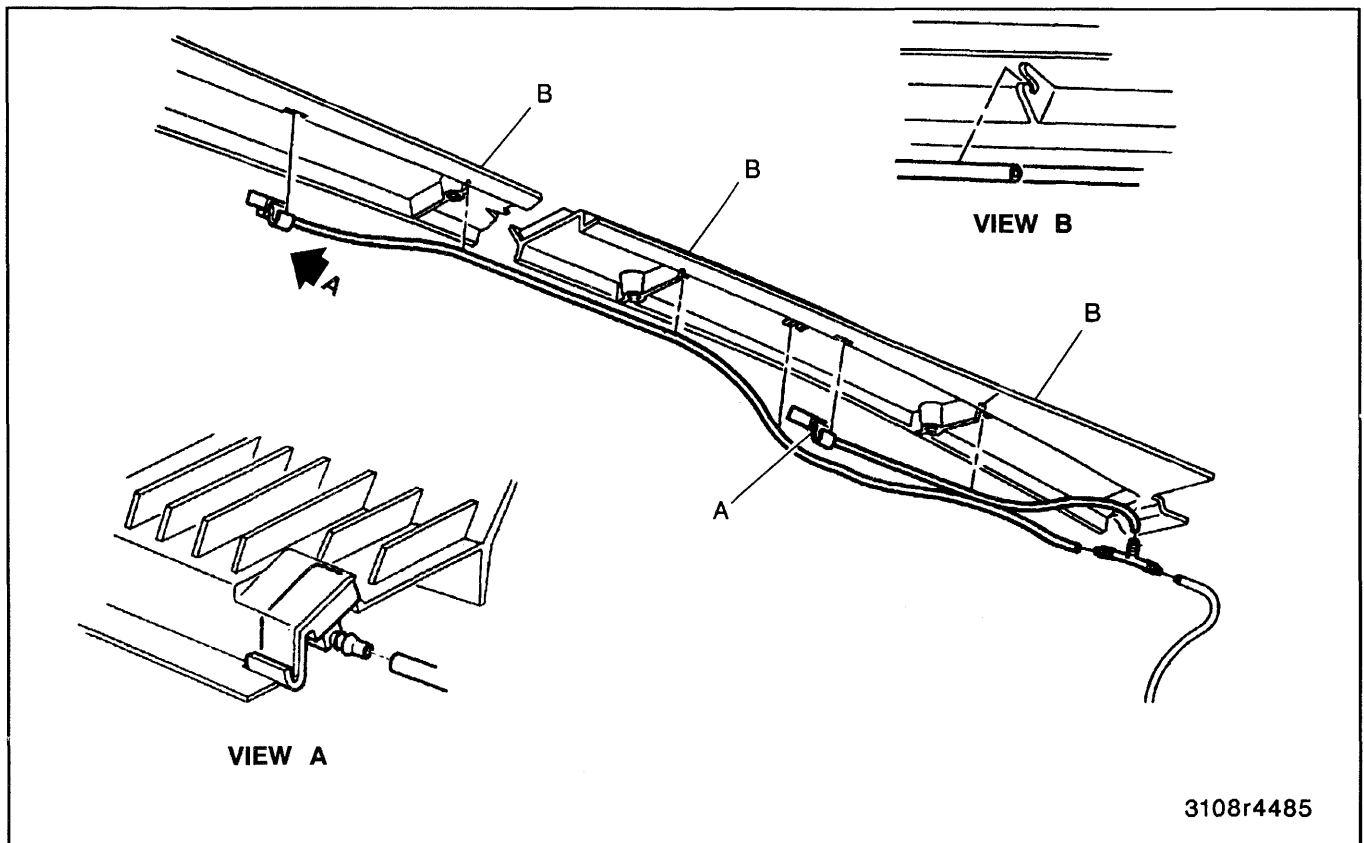


Figure 3—Washer Hose Routing (Cowl)

For an immediate wiping activity, rotate the wiper switch to the "MIST" position. The wiping activity will continue as long as the switch is held.

WASHER HOSE ROUTING

Washer hose routing begins at two nozzles mounted to the cowl vent grille (figure 3). The hose is clipped in various places to the cowl vent grille, then exits the

cowl area through a grommet on the engine side of the cowl (figure 4). The hose is strapped to the forward lamp harness and runs a parallel path along the left inner fender to the washer solvent container and finally, to the washer pump motor. A one-way check valve between the hose and pump motor assembly allows fluid flow in one direction only.

8E1-4 WINDSHIELD WIPER/WASHER SYSTEM

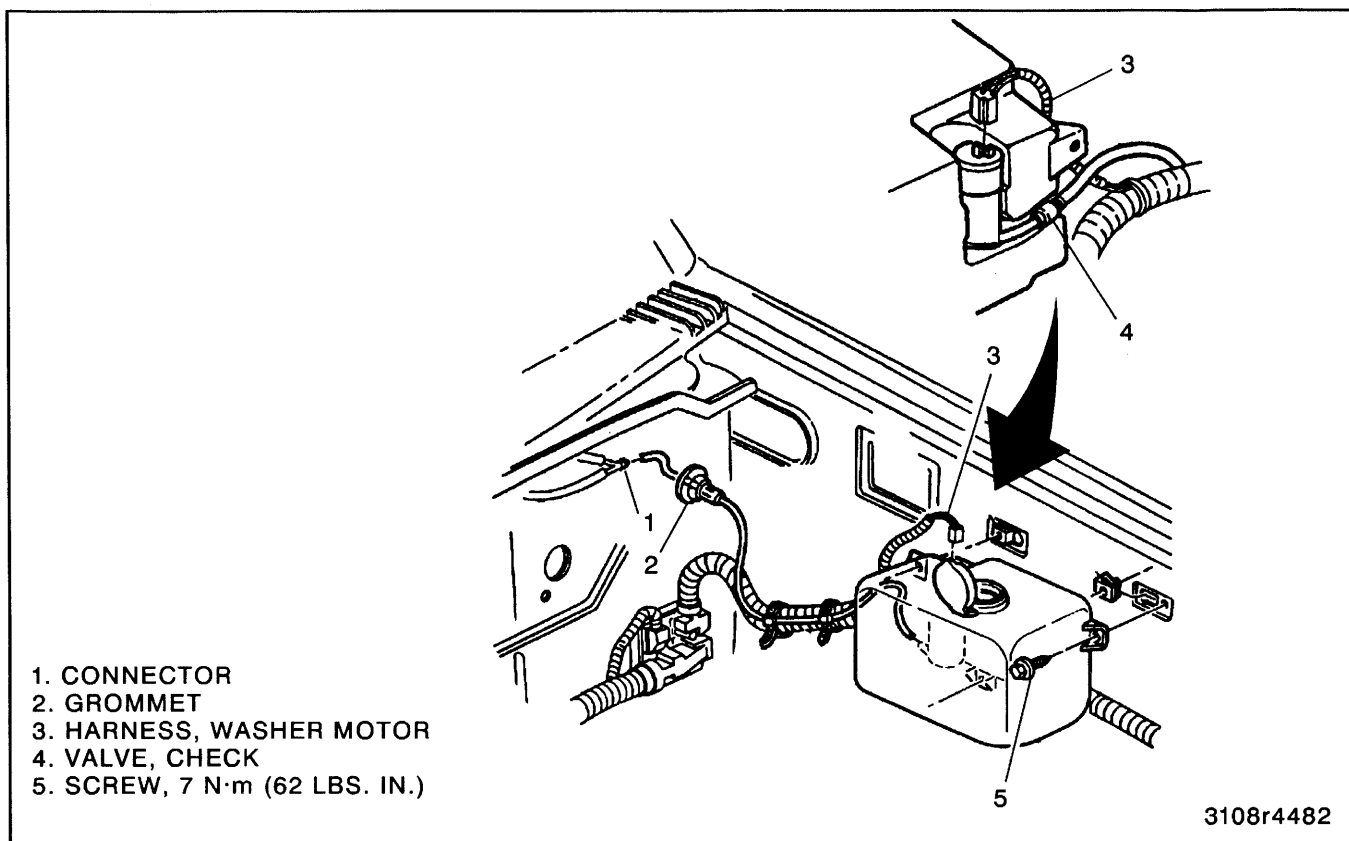


Figure 4—Washer Hose Routing (Container)

DIAGNOSIS OF THE WIPER/WASHER SYSTEM

WIPER ARM CHATTER

If the wipers chatter or shudder when wiping the windshield, the windshield and/or blades may need cleaning. Use a non-abrasive cleaner such as Bon Ami® to clean the windshield. Continue cleaning until water sheets off the windshield. Use undiluted windshield wiper/washer solvent and a clean, lint-free cloth to clean wiper elements.

CAUTION: Avoid prolonged skin contact with washer solvent to avoid damage to your skin. Overexposure may cause central nervous system effects.

When marking the windshield for inside rearview mirror replacement or any other purpose, use only a water-soluble marker to make marks on the windshield. Other types of markers may damage the wiper blades. The chemicals that are used to remove other types of markers may damage the paint, glass, blades, or leave a residue on the glass which could lead to blade chatter.

Wiper arms must not be subjected to temperatures above 70°C (160°F). Remove wiper arms before any painting operations that include the use of an oven to cure the paint.

CHECKING WIPER ARM PRESSURE

If the wipers miss or shudder when wiping the windshield, and the windshield and wiper blades have been cleaned, the wiper arm pressure should be checked. Refer to figure 5. If the wiper arms are not within the specifications given in figure 5, they should be replaced. Refer to "Wiper Arm Assembly Replacement."

BLADE ELEMENT SET CHECK

Remove the wiper blade assemblies from the wiper arms. Look down the length of the blade element (figure 6). The rubber element that contacts the glass must be on the centerline of the blade assembly ± 15 degrees. Replace the element if necessary.

WIPER MOTOR ASSEMBLY DIAGNOSIS

Always perform the system check first as a guide to normal operation. Then refer to figures 7 through 16 for wiper motor assembly diagnosis. The electrical diagrams and diagnosis section of NATP-9442 contains diagnostic procedures for vehicle wiring.

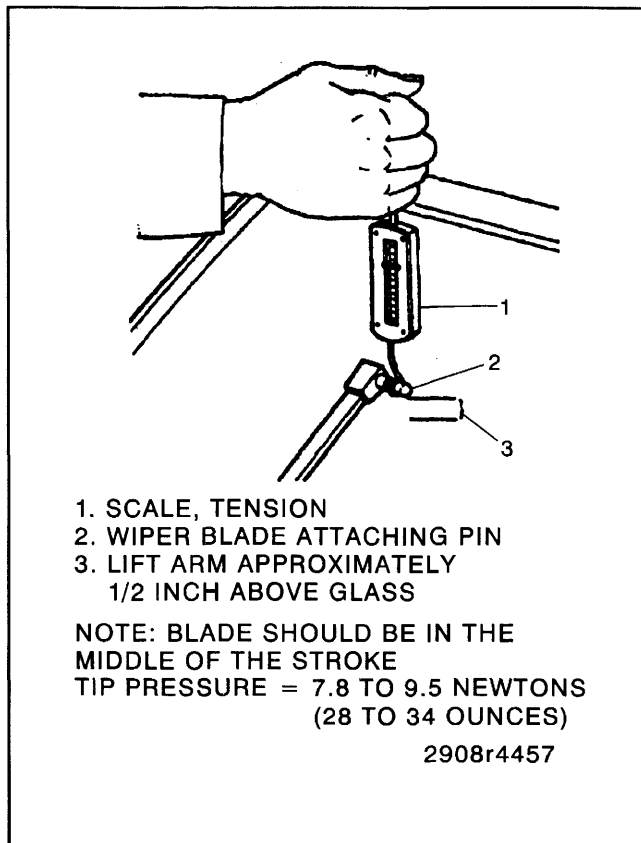


Figure 5—Checking Wiper Arm Pressure

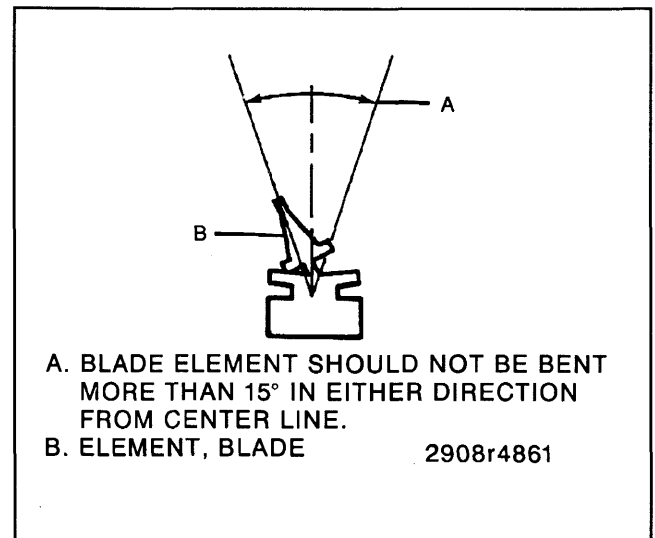


Figure 6—Blade Element Set Check

PULSE WIPER SYSTEM CHECK

ACTION	NORMAL OPERATION
1. Ignition switch in ACCY or RUN. • Hold washer switch ON for 1 to 2 seconds.	1. Washer sprays windshield until switch is released. Wipers run at low speed and continue to run for approximately 6 seconds after washer cycle is complete, then return to park position.
2. Turn wiper switch to DELAY (pulse mode). • Activate delay time by turning wiper switch through delay range.	2. Wipers make one complete sweep, then pause for 0 to 25 seconds before making next sweep.
3. Wiper switch in DELAY. • Push washer switch ON for 1 to 2 seconds.	3. Washers sprays as long as washer switch is held ON. Wipers run at low speed during spray period and continue for approximately 6 seconds after spray cycle. Wipers return to pulse mode.
4. Turn wiper switch to LO.	4. Wipers run continuously at low speed.
5. Turn wiper switch to HI.	5. Wipers run at faster speed.
6. Turn wiper switch to OFF.	6. Wipers return to park position at low speed.
7. Turn wiper switch to MIST, then release.	7. Wipers make one complete sweep at low speed and park. If switch is held in MIST, wipers run continuously at low speed until switch is released.

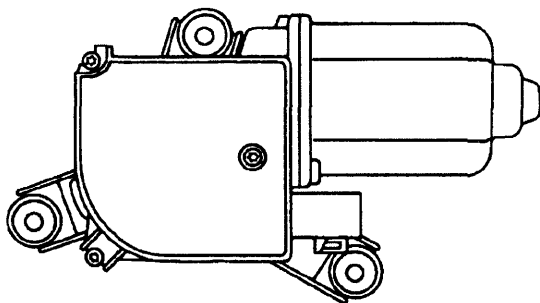
DIAGNOSTIC PROCEDURES

NOTE: The following procedures assume that the technician has checked the following:

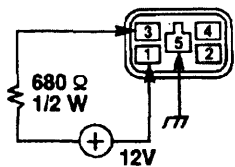
1. Continuity of all harness wires
2. Wiper motor-to-cowl mounting screws tight
3. Fuses
4. Washer hoses clear

WIPER MOTOR

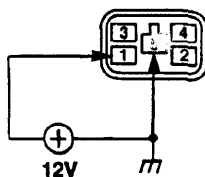
CHECK FOR MOTOR OPERATION BEFORE REMOVING FROM VEHICLE. DISCONNECT ALL WIRING FROM WIPER AND PERFORM THE FOLLOWING CHECKS IN THIS ORDER:



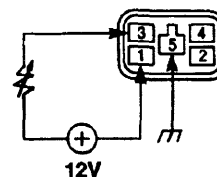
① MIST



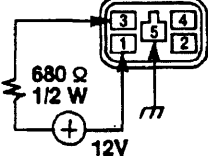
② OFF/PARK



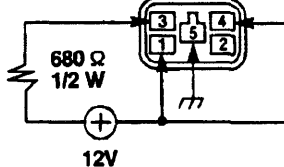
③ PULSE



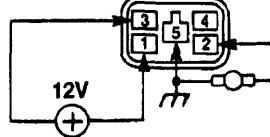
④ LO



⑤ HI



⑥ WASH



NOTE: Connect terminal #3 before connecting terminal #4. Otherwise damage to P.C. board may occur.

Connect a test pump (bottom-bottle-mount type) of proven quality. Do not use pump off vehicle. Test washer pump should pulse 9 to 11 times in 15 seconds. Do not hold WASH button longer than this without a 2 minute pause.

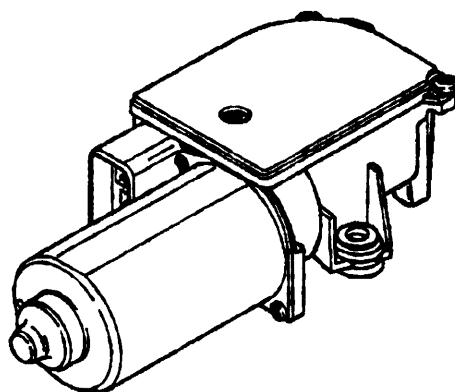
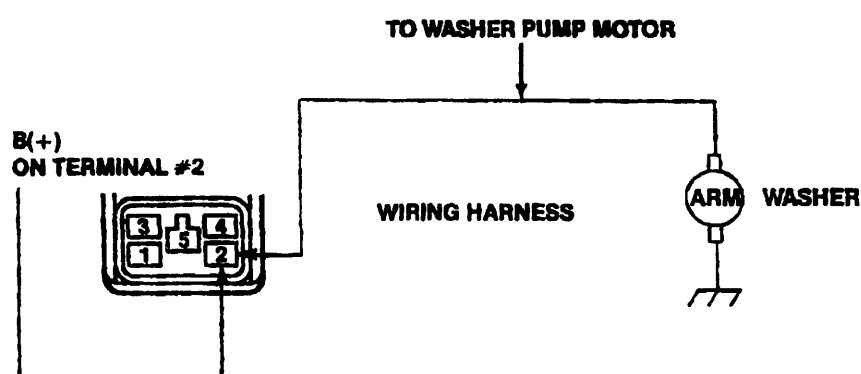
1. If wiper motor functions in all above modes, go to Wiper-Washer Switch Tests.
2. If the motor does not function in any of the above checks, see Diagnosis Chart.

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Figure 7—Wiper Motor On-Vehicle Check

DIAGNOSTIC PROCEDURES (CONT'D)**WASHER PUMP**

CHECK FOR WASHER PUMP OPERATION BEFORE REMOVING FROM VEHICLE. REMOVE CONNECTOR AND APPLY B(+) TO #2 WIRING HARNESS TERMINAL AS SHOWN.



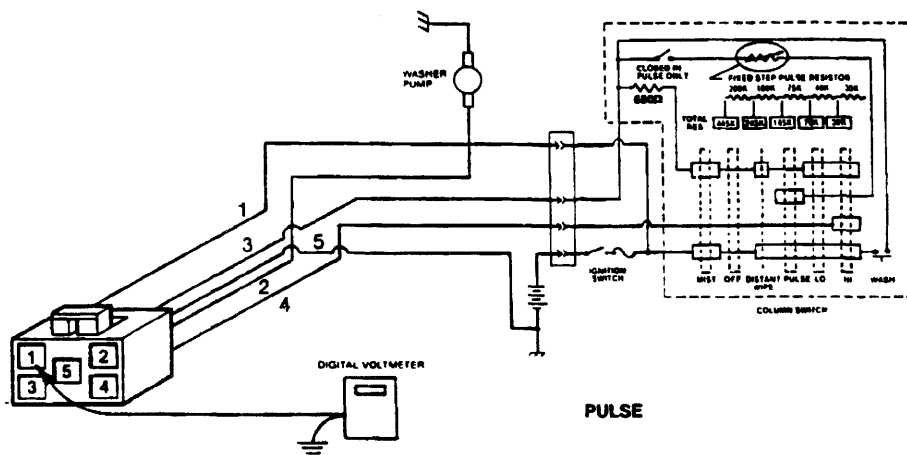
1. If motor does not run or pump solvent, replace washer pump.
2. If motor runs and pumps solvent, problem is in circuit board, motor park switch or wiper switch. Refer to Wiper-Washer Switch Tests.

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Figure 8—Washer Pump On-Vehicle Check

WIPER-WASHER SWITCH TESTS

Disconnect wiring harnesses from wiper motor and perform the following switch tests using a digital voltmeter and ignition switch on:



		SWITCH MODE					
		MIST	OFF	PULSE	LO	HI	WASH
PULSE	1	B+	B+	B+	B+	B+	B+
	2	—	—	—	—	—	C
	3	B+	—	B+	B+	C	C
	4	—	—	—	—	C	—
	5	—	—	—	—	—	—

NOTE: All voltage readings taken with respect to vehicle ground.

C = Continuity between terminals

To use Wiper-Washer Switch Check chart, probe terminals 1 thru 5 with digital voltmeter and wiper switch in various positions.

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Figure 9—Wiper/Washer Switch Tests

SYMPTOM	PROCEDURE NO.
1. Pump inoperative—wiper motor operates	1
2. Washer pumps continuously	2
3. Wiper motor inoperative (all modes)	3
4. "Lo" speed only—inoperative in "Hi"	4
5. "Hi" speed only—inoperative in "Lo"	5
6. One speed only—runs the same in both speeds	6
7. Wiper shuts off but blades don't park	7
8. Wiper will not shut off	8
9. Intermittent inoperative	9
10. Wiper motor runs but blades don't move	10
11. Wiper parks above park position	11

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Figure 10-Symptom Diagnosis Chart

8E1-10 WINDSHIELD WIPER/WASHER SYSTEM

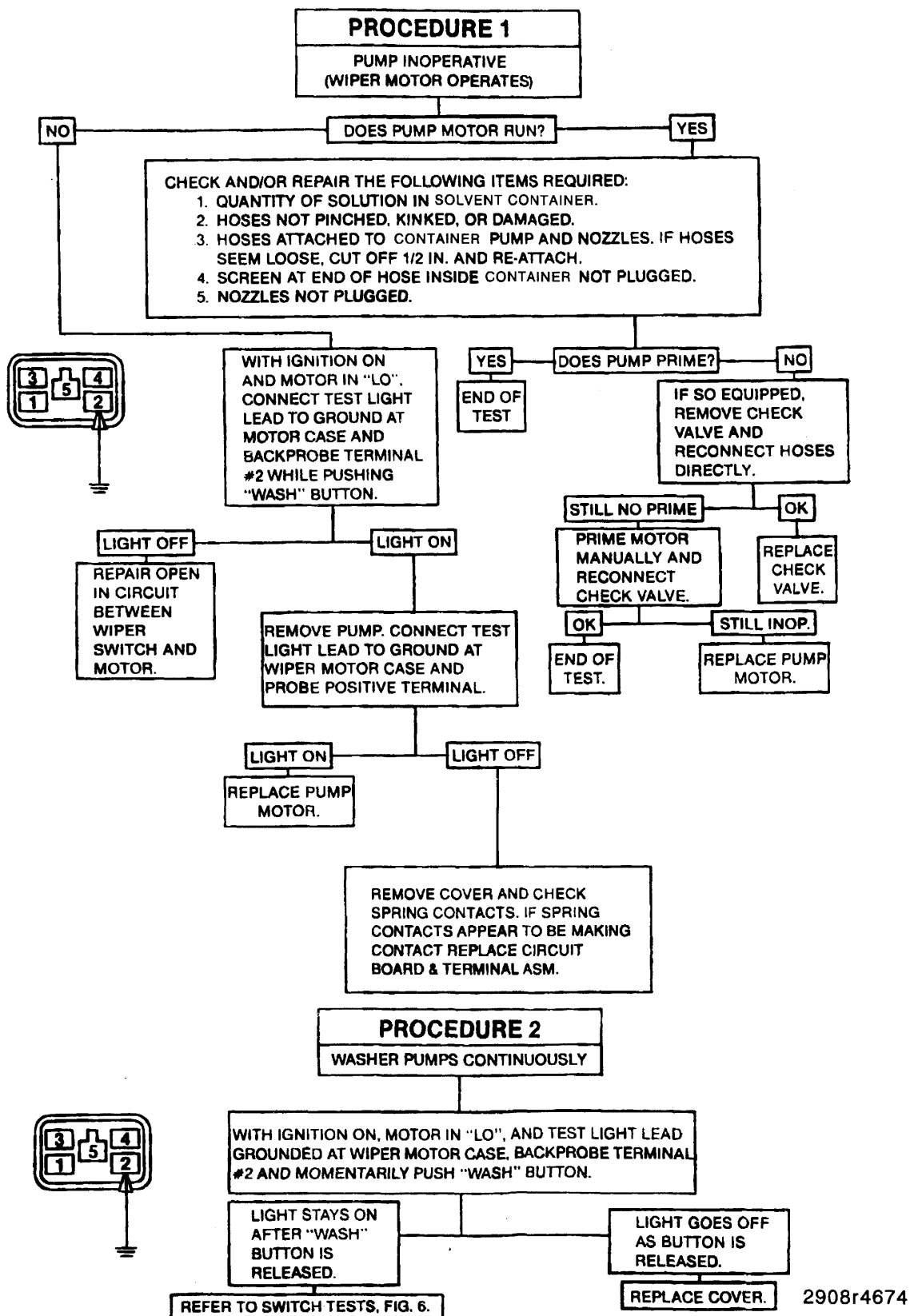


Figure 11—Wiper/Washer Diagnosis (1 of 6)

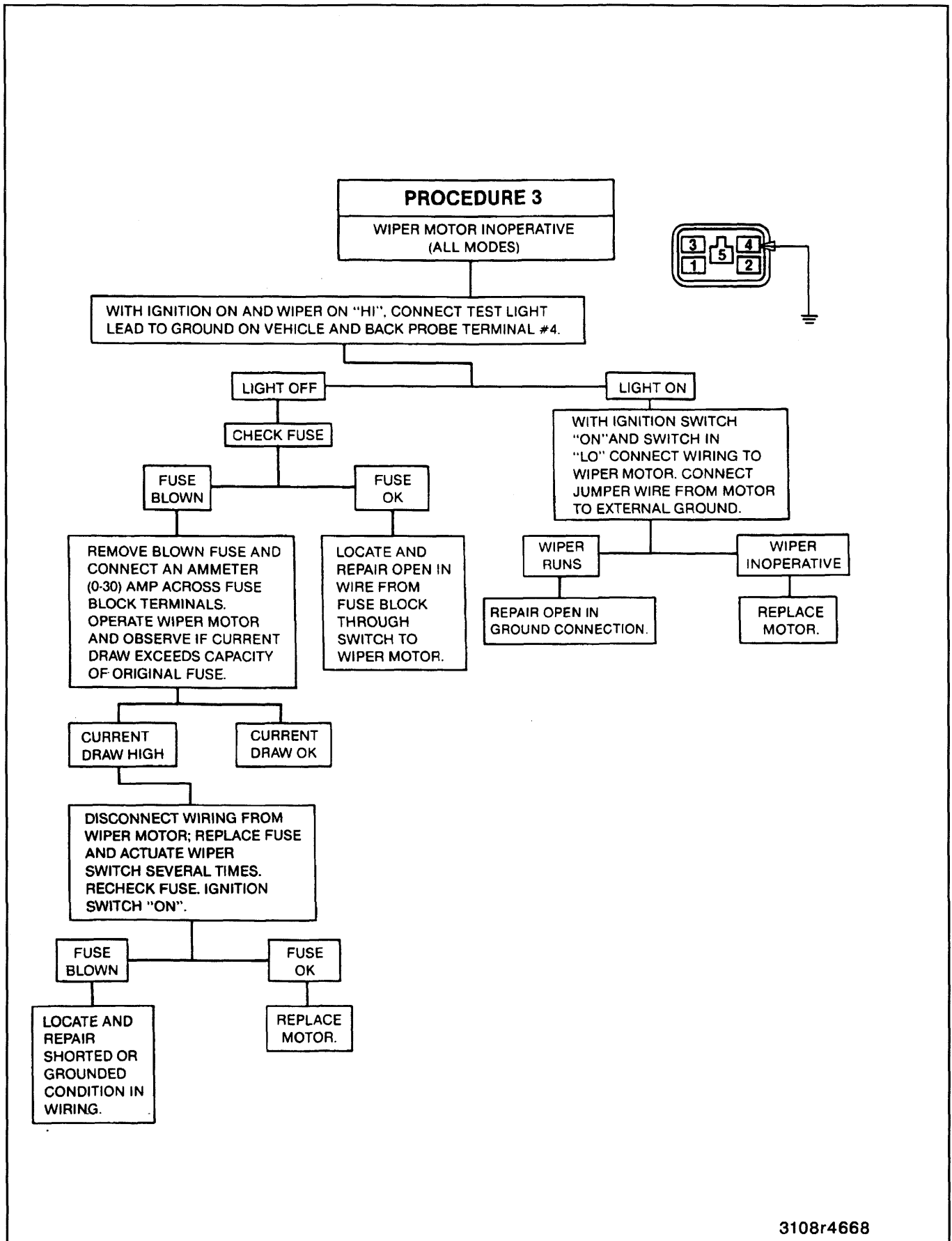


Figure 12—Wiper/Washer Diagnosis (2 of 6)

8E1-12 WINDSHIELD WIPER/WASHER SYSTEM

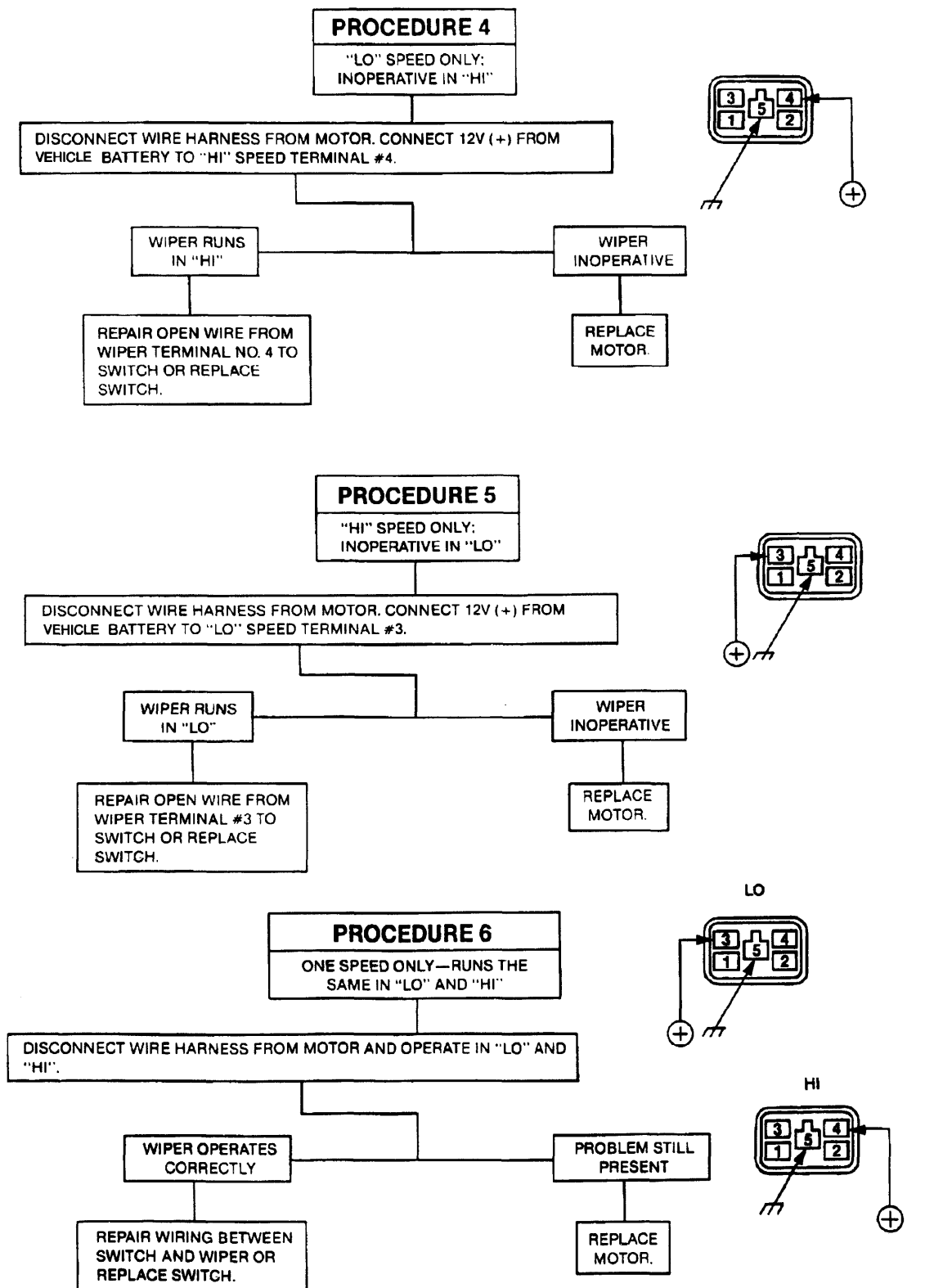
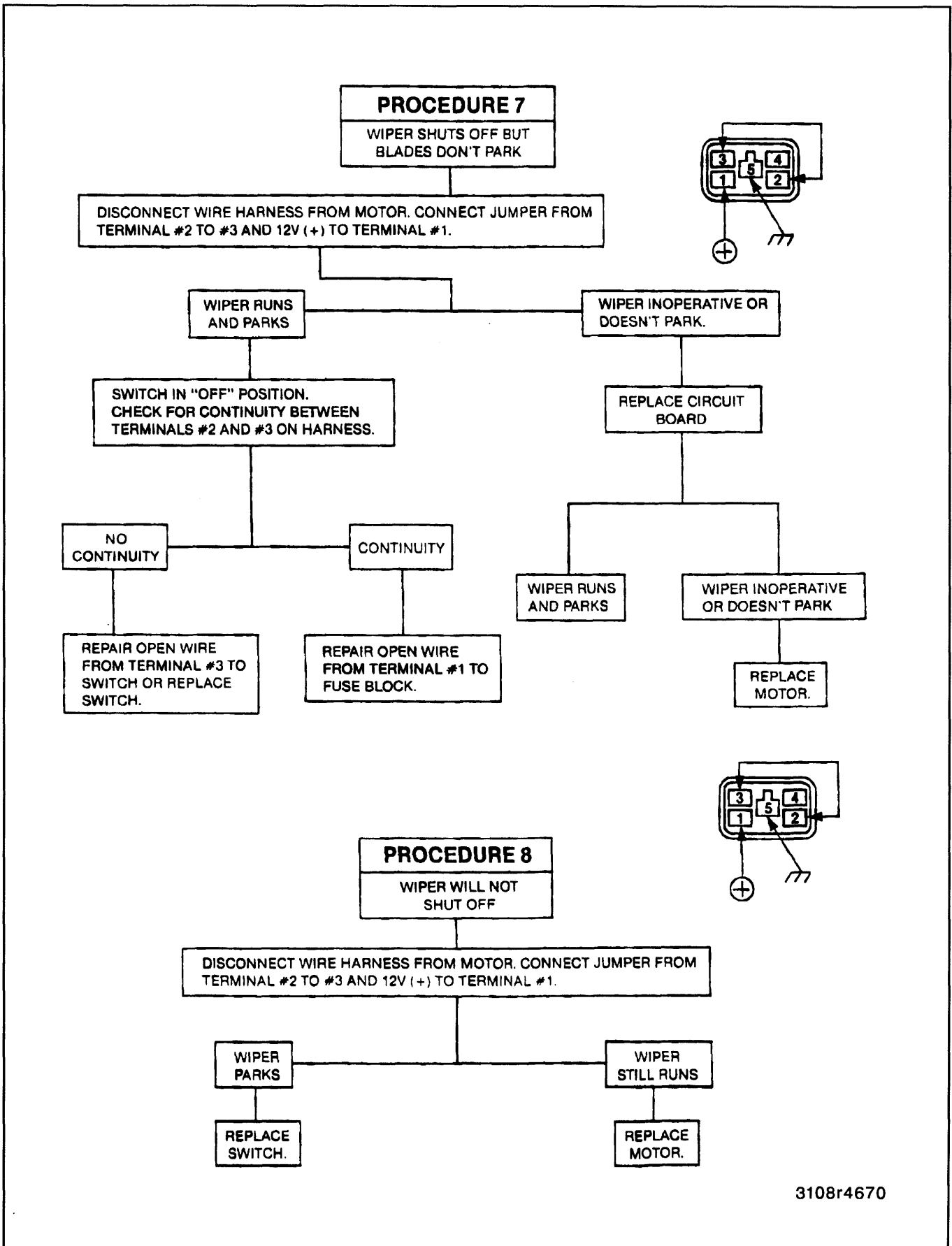


Figure 13—Wiper/Washer Diagnosis (3 of 6)



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Figure 14—Wiper/Washer Diagnosis (4 of 6)

8E1-14 WINDSHIELD WIPER/WASHER SYSTEM

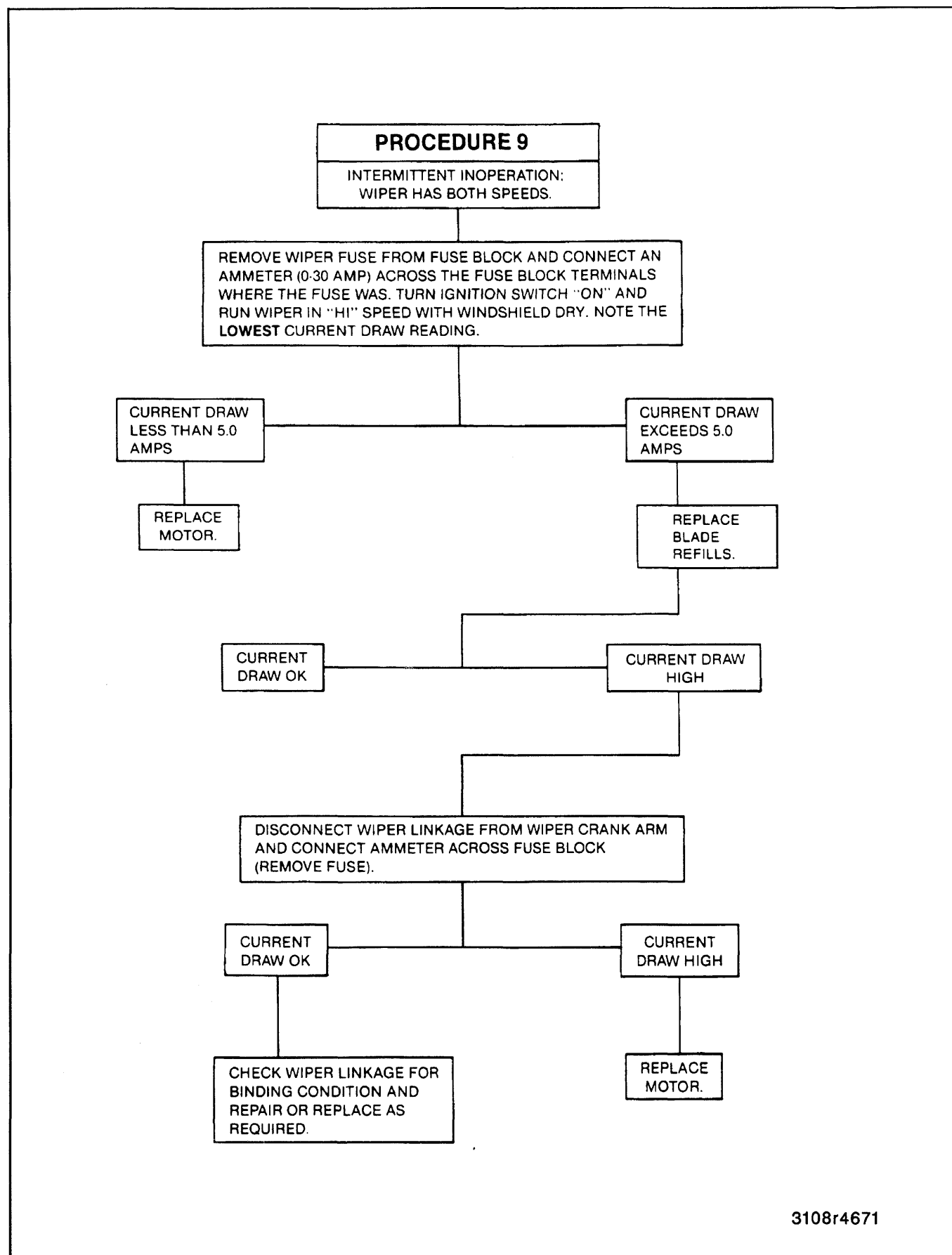
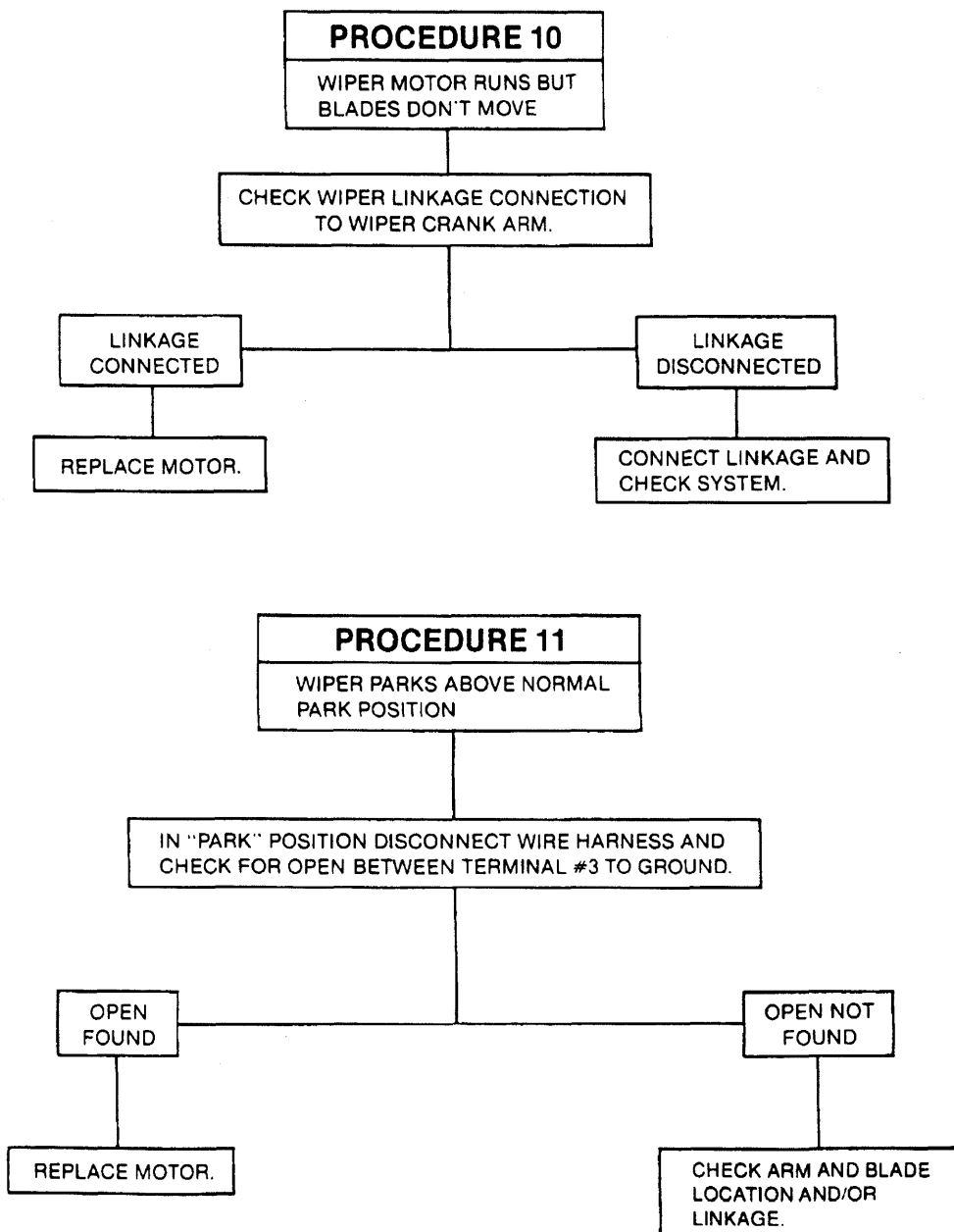


Figure 15—Wiper/Washer Diagnosis (5 of 6)



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Figure 16—Wiper/Washer Diagnosis (6 of 6)

ON-VEHICLE SERVICE

WIPER ARM ASSEMBLY REPLACEMENT

! Important

- Before removing one or both arm and blade assemblies, use a suitable marker on the windshield to indicate proper park position to aid in reinstallation.

↔ Remove or Disconnect (Figure 17)

1. Washer hose.
2. Lift the wiper arm assembly from windshield, then pull retaining latch.
3. Arm assembly from transmission drive shaft.

↔ Install or Connect (Figure 17)

1. Position wiper arm assembly on the drive shaft so that the wiper blade aligns with the mark made before removal.
 - Seat the arm assembly on the drive shaft, then press in retaining latch.
2. Washer hose.

👁 Inspect Wiper Operation

- Run wipers and check wipe pattern and blade tip park position.

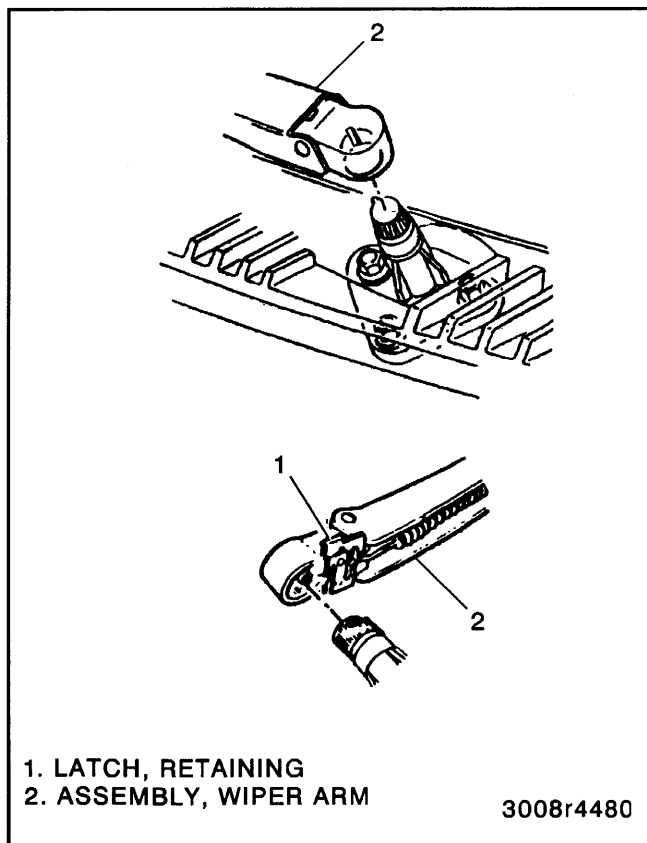


Figure 17—Wiper Arm Attachment

WIPER BLADE ASSEMBLY AND ELEMENT REPLACEMENT

↔ Remove or Disconnect (Figure 18)

1. Wiper blade assembly from the arm assembly.
 - Insert a narrow-bladed screwdriver into the slot over the retainer spring. Pivot the screwdriver so that the blade tip presses downward on the retainer spring and release the blade from the pin of the wiper arm assembly.
2. Element from blade assembly.
 - Squeeze locking tabs together and pull the element from the blade assembly.

! Important

- Element must be replaced if removed.

↔ Install or Connect (Figure 18)

1. Element to the blade assembly.
 - A. Position retainer at bottom end of blade assembly.
 - B. Guide element through blade assembly, being sure to engage the claw sets along the entire length of the blade.

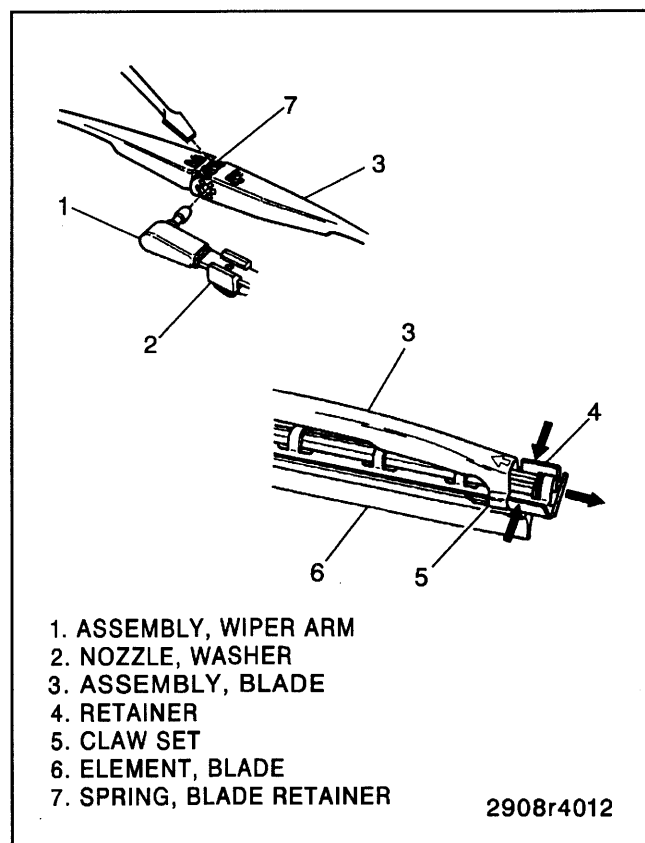


Figure 18—Wiper Blade Assembly and Element Replacement

- C. Element is fully seated when both locking tabs engage the claw set.
2. Blade assembly to the wiper arm assembly by snapping it into place.

CIRCUIT BOARD AND TERMINAL ASSEMBLY REPLACEMENT

Remove or Disconnect (Figure 19)

1. Negative battery cable. Refer to SECTION 0A.
2. Wiper motor electrical connector.
3. Cover screws.
4. Cover.
5. Circuit board and terminal assembly by lifting up on terminal.

Install or Connect (Figure 19)

1. Circuit board and terminal assembly.

NOTICE: Refer to "Notice" on page 8E1-1.

2. Cover and three screws.

Tighten

- Screws to 2.6 N·m (23 lbs. in.).
3. Wiper motor electrical connector.
 4. Negative battery cable.

WIPER TRANSMISSION ASSEMBLY REPLACEMENT

Remove or Disconnect (Figure 20)

1. Wiper arm assemblies. Refer to "Wiper Arm Assembly Replacement."
2. Cowl vent grille. Refer to SECTION 2B.
3. Loosen bracket to crank arm nuts.
4. Transmission brackets from the wiper motor crank arm.
5. Transmission to cowl bolts.
 - Note the position of the right and left transmission links for reassembly.
6. Transmission assembly from the vehicle.

Install or Connect (Figure 20)

NOTICE: For steps 2, and 4, refer to "Notice" on page 8E1-1.

1. Wiper transmission assembly to the vehicle.
2. Transmission to cowl bolts.

Tighten

- Bolts to 7 N·m (62 lbs. in.).
3. Transmission brackets to the wiper motor crank arm.

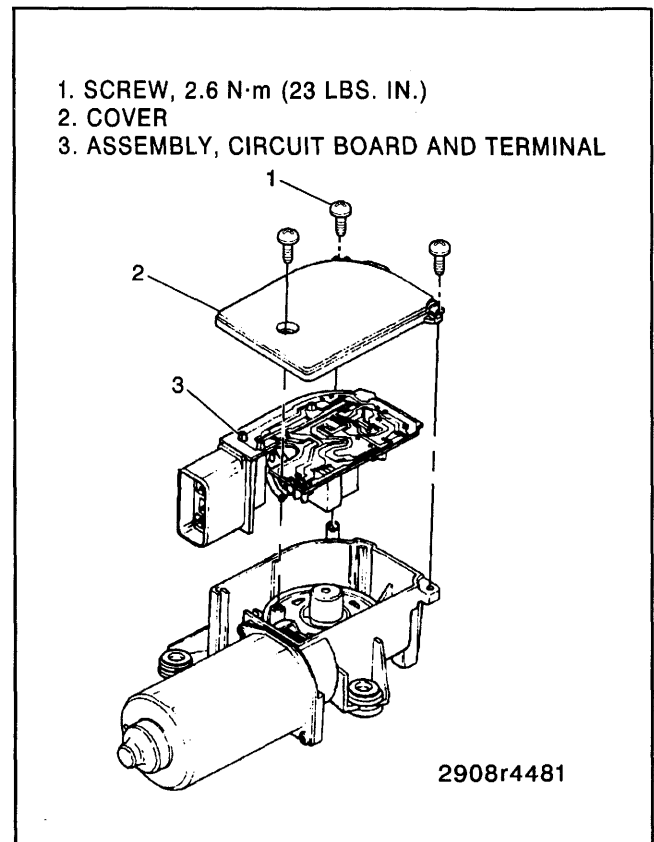


Figure 19—Circuit Board and Terminal Assembly Replacement

Tighten

- Drive link nuts to 5 N·m (44 lbs. in.).
4. Cowl vent grille. Refer to SECTION 2B.
 5. Wiper arm assemblies. Refer to "Wiper Arm Assembly Replacement."

WIPER MOTOR ASSEMBLY REPLACEMENT

Remove or Disconnect (Figures 17 and 20)

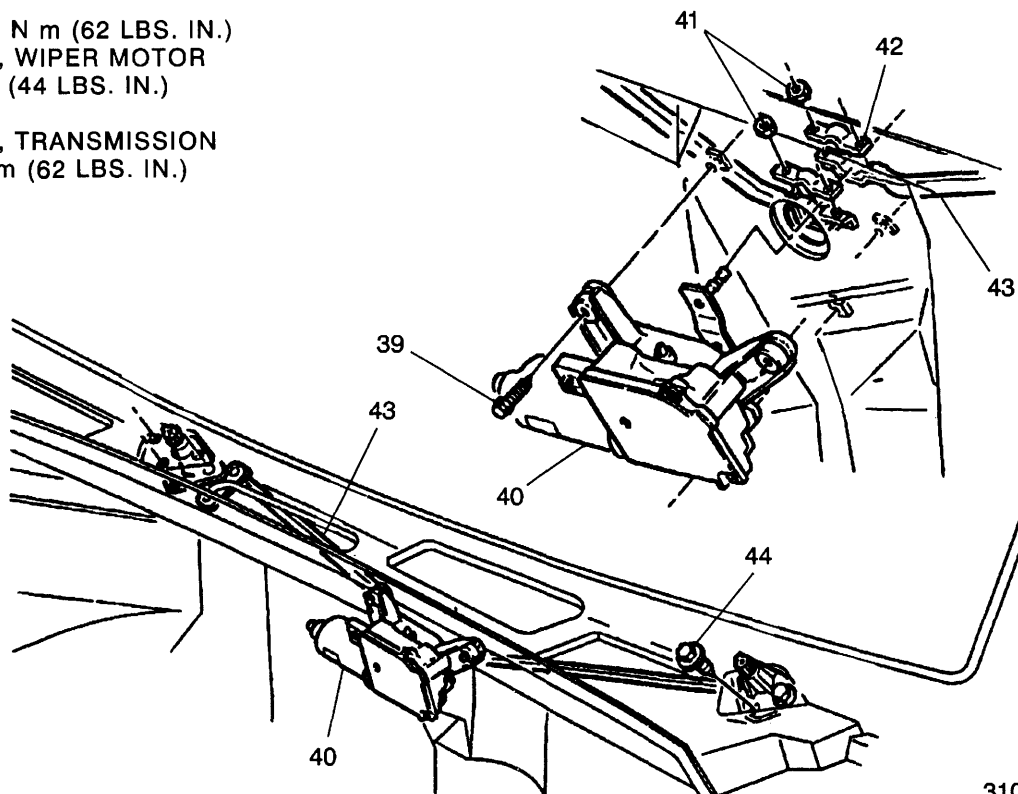
1. Negative battery cable. Refer to SECTION 0A.
2. Wiper arm assemblies.
 - Lift the wiper arm into the servicing position, and move the latch into the open position before removing the wiper arm (figure 17).
3. Cowl vent grille. Refer to SECTION 2B.
4. Wiring connector from the motor assembly.
5. Drive link brackets from the wiper motor crank arm. **DO NOT REMOVE THE CRANK ARM.**
 - Loosen the nuts and slide the brackets off the crank arm.
6. Wiper motor screws and wiper motor assembly from the vehicle.

Install or Connect (Figures 17 and 20)

NOTICE: For steps 2 and 3, refer to "Notice" on page 8E1-1.

8E1-18 WINDSHIELD WIPER/WASHER SYSTEM

- 39. SCREWS, 7 N·m (62 LBS. IN.)
- 40. ASSEMBLY, WIPER MOTOR
- 41. NUT, 5 N·m (44 LBS. IN.)
- 42. BRACKET
- 43. ASSEMBLY, TRANSMISSION
- 44. BOLT, 7 N·m (62 LBS. IN.)



3108r4465

Figure 20—Wiper Transmission and Motor Assembly Replacement

1. Wiper motor assembly to the vehicle.
2. Wiper motor screws.



Tighten

- Screws to 7 N·m (62 lbs. in.).

3. Drive link brackets to the wiper motor crank arm.
 - Assemble the brackets in the order shown in figure 20. (Right side linkage closest to the wiper motor).



Tighten

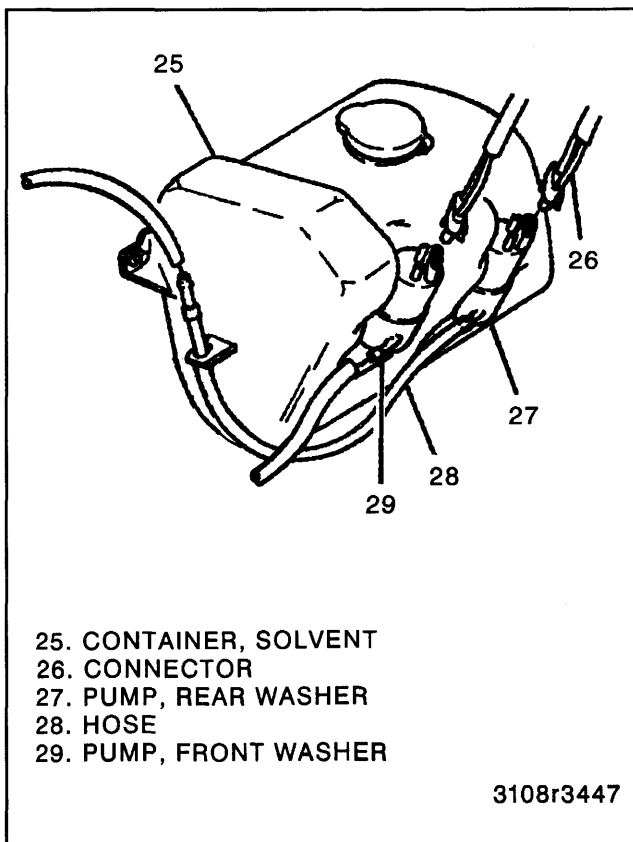
- Drive link nuts to 5 N·m (44 lbs. in.).

4. Wiring connector to the wiper motor.
5. Cowl vent grille. Refer to SECTION 2B.
6. Wiper arm assemblies.
 - Place the wiper arms on the transmission drive shafts and lock them into place with the latch (figure 17).
7. Negative battery cable.

WIPER/WASHER SWITCH ASSEMBLY REPLACEMENT

The wiper/washer switch assembly is part of the steering column assembly. For replacement procedures without optional cruise control, refer to SECTION 3F.

The multifunction lever is part of the optional cruise control. For replacement procedures, refer to SECTION 9B.



- 25. CONTAINER, SOLVENT
- 26. CONNECTOR
- 27. PUMP, REAR WASHER
- 28. HOSE
- 29. PUMP, FRONT WASHER

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Figure 21—Washer System Components

WASHER SOLVENT CONTAINER AND PUMP REPLACEMENT



Remove or Disconnect (Figure 21)

1. Negative battery cable. Refer to SECTION 0A.
2. Wiring connectors from both washer pumps (if equipped).
3. Hose(s) from washer pump connectors.
4. Solvent container bolts.
5. Container from the vehicle.
6. Washer pump(s) from the container.



Install or Connect (Figure 21)

1. Washer pump(s) to the solvent container.
 - Make sure washer pump(s) are pushed all the way into the container seals.

2. Solvent container to the vehicle.

NOTICE: Refer to "Notice" on page 8E1-1.

3. Container bolts.



Tighten

- Container bolts to 12 N.m (106 lbs. in.).
4. Washer hose(s) to pump connectors.
 5. Wiring connectors to both washer pumps (if equipped).
 6. Negative battery cable.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N·m	Lbs. In.
Container Bolts	12	106
Circuit Board and Terminal Assembly Cover Screws	2.6	23
Transmission Assembly Drive Link Nuts	5	44
Transmission to Cowl Bolts	7	62
Wiper Motor to Cowl Screws	7	62
		T2854

NOTES

SECTION 8E2

REAR WINDOW WIPER/WASHER SYSTEM

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

REAR WINDOW WIPER/WASHER SYSTEM

The rear window wiper/washer system has a one-speed, permanent magnet, depressed park wiper motor assembly with a pulse (delay) mode (figure 1). The wiper motor assembly drives a gear box, that in turn drives a wiper pivot that provides an oscillating output to the arm and blade.

A controller assembly is retained by the wiper motor bracket and is the only replaceable wiper motor component. The controller's printed circuit board controls all wiper motor functions as determined by the position of the wiper/washer switch (figure 2).

SYSTEM OPERATION

The system operates only with the ignition switch is in the "RUN" or "ACC" position. There are four electrical terminals on the controller assembly of the wiper motor assembly (figures 3 and 4).

When the wiper switch is turned "ON," battery voltage is applied to terminal B of the controller. The motor and controller are grounded at terminal A. If the delay button is pressed, battery voltage is applied to terminals B and

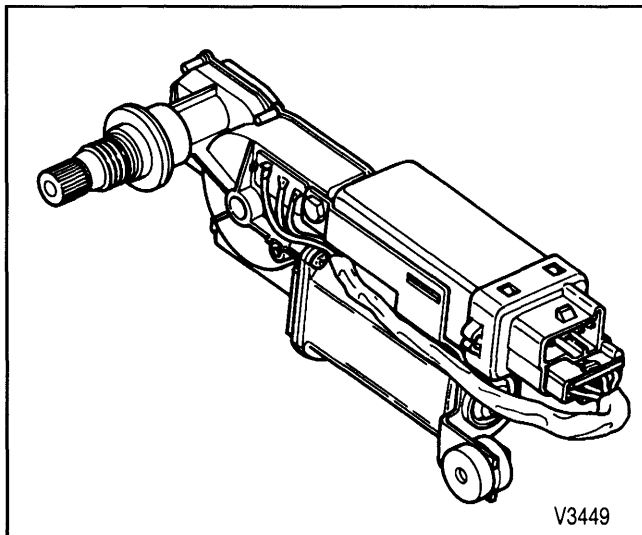


Figure 1—Wiper Motor Assembly

8E2-2 REAR WINDOW WIPER/WASHER SYSTEM

D at the controller. The operation of the wiper motor will be pulsed, with about 9 seconds between each wiper sweep.

When the wiper switch is turned "OFF," only terminals A and D are used. D remains battery positive and the circuit is completed through terminal A and the closed park switch terminals. A cam on the wiper motor gear then opens at the park position and the wiper motor turns off.

CONTAINER-MOUNTED WASHER SYSTEM

The rear washer pump and solvent container mounts to the left fender, inside the engine compartment. The rear window wiper/washer will always run out of solvent before the windshield wiper/washer does. If the rear washer fails to operate, try washing the windshield. If you are able to wash the windshield and not the rear window, try filling the solvent container.

The washer hose routes from the solvent container, along the inside of the left frame rail to the rear of the vehicle (figure 5). A one-way check valve between the

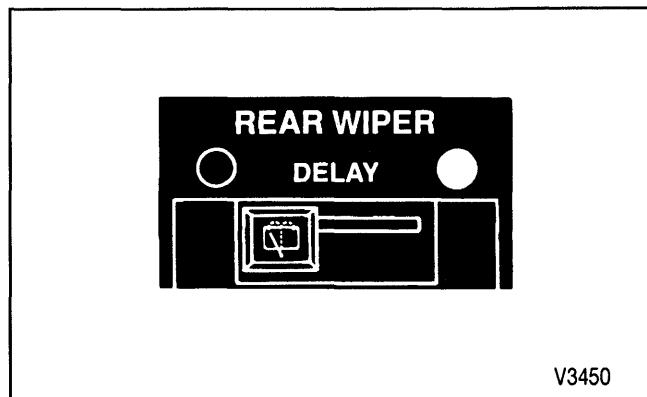


Figure 2—Wiper/Washer Switch Assembly

washer pump motor assembly and the washer hose harness allows fluid flow toward the washer nozzle only. A second check valve is behind the rear bumper, where the hose continues up the right side of the door opening frame, across the vehicle to the rear window wiper motor assembly (figure 6).

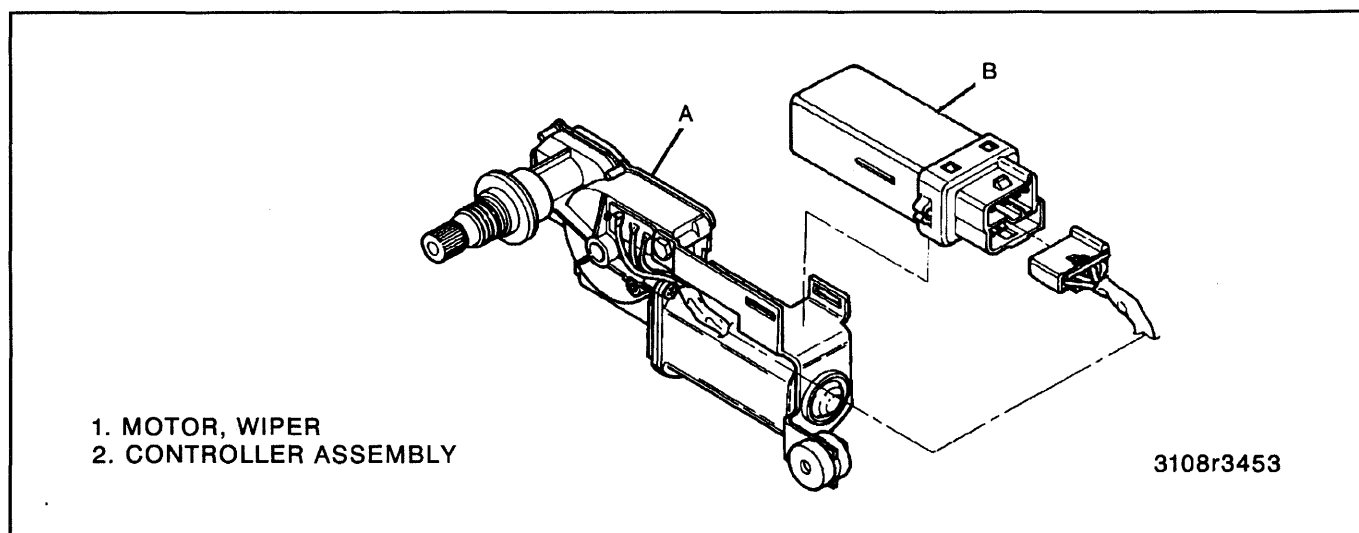


Figure 3—Wiper Motor Assembly Components

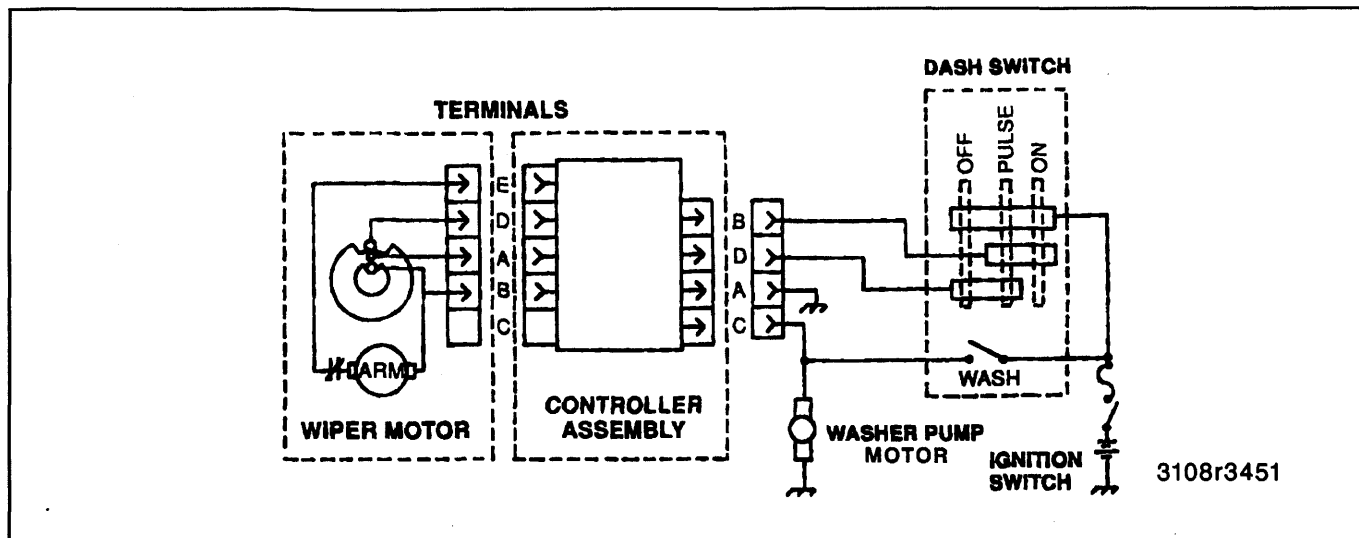


Figure 4—Wiper/Washer Motor Circuit Diagram

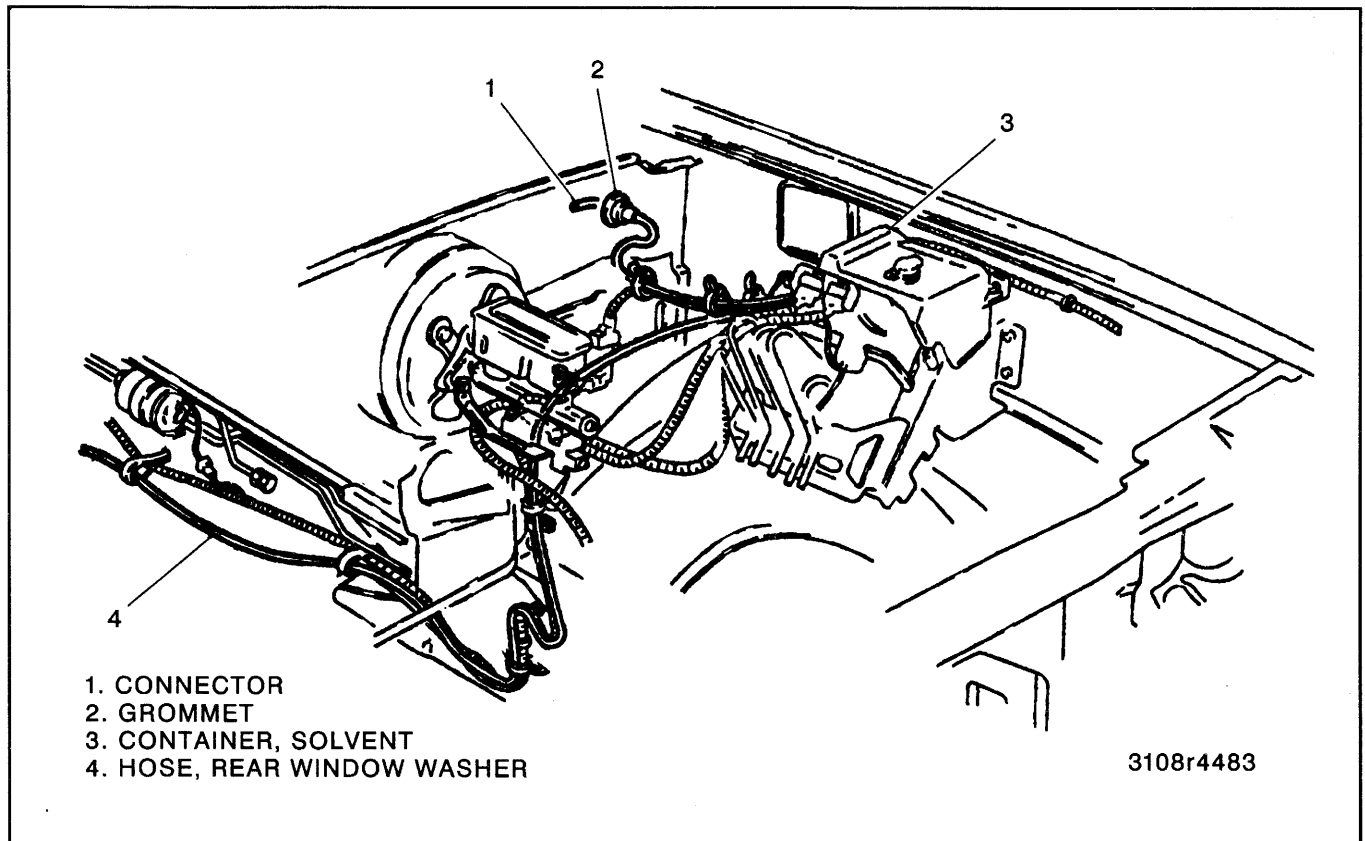


Figure 5—Washer Hose Routing (Front)

Depressing the wash button while the wiper motor operates in either "DELAY" or "ON" completes the washer motor's circuit to ground, energizing the motor and operating the washer pump. The pump operates only while the wash button is held. When the button is released, approximately 3 wipes are made without washing activity before the wiper motor turns off.

A "demand" wash will be performed if the wash button is pressed with the wiper/washer switch in the "OFF" position. The wash action will last until the wash button is released, followed by approximately 3 wipes without washing activity before the wiper motor turns off.

8E2-4 REAR WINDOW WIPER/WASHER SYSTEM

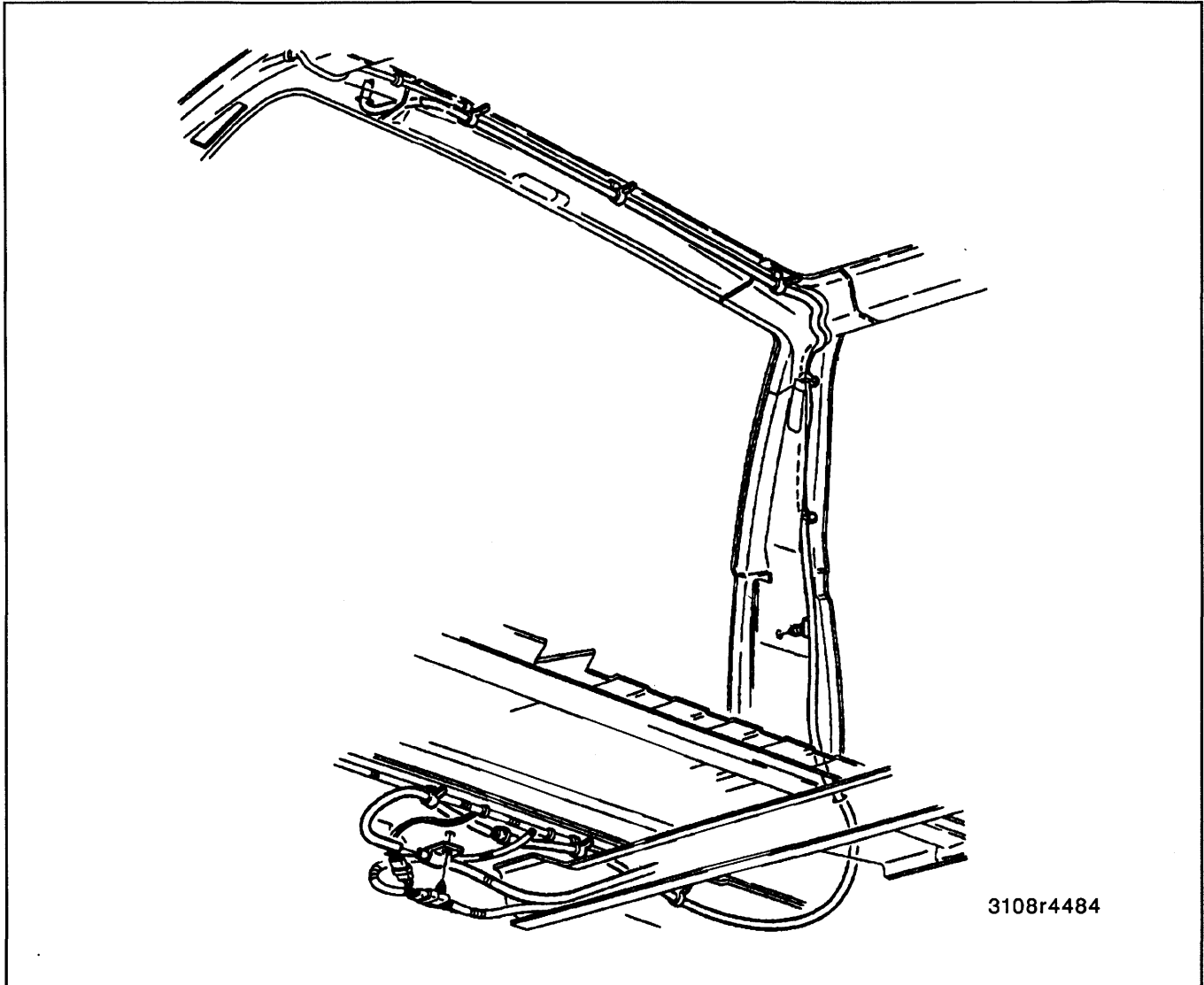


Figure 6—Washer Hose Routing (Rear)

DIAGNOSIS OF THE REAR WINDOW WIPER/WASHER SYSTEM

Always perform the System Check first as a guide to normal operation, then verify that power and ground are at the correct wiper motor terminals using "Controller Terminals Used in RUN." The wiper motor and controller assemblies cannot be repaired. If diagnosis leads to a faulty motor or controller, replace them. The electrical diagrams section of NATP-9442 provides circuit diagrams and harness diagnosis.

CONTROLLER TERMINALS USED IN "RUN"

"RUN" OR "ON" MODE TERMINALS	BATTERY VOLTAGE AT TERMINALS	GROUND TERMINAL
A, B, & C	A & C	B

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SYSTEM CHECK

ACTION	NORMAL OPERATION
1. Slide the rear window wiper switch to the middle position.	1. Wiper operates in delay mode. A wipe is performed approximately every 9 seconds.
1. Slide the rear window wiper switch all the way to the right.	1. Wiper operates at a constant speed.
1. With wiper running, push wiper switch in.	1. Washer fluid sprays back window until switch is released. Wiper continues to operate.
1. Slide the rear window wiper switch all the way to the left.	1. Wiper returns to park position.

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ON-VEHICLE SERVICE

WIPER ARM ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 7)

1. Washer hose.
2. Lift the wiper arm assembly from the glass and pull the retaining latch.
3. Wiper arm assembly from the wiper motor driveshaft.



Install or Connect (Figure 7)

1. Wiper arm assembly with the wiper motor in the park position.
 - A. Install the head of the wiper arm assembly onto the serrated wiper motor driveshaft in a position where the blade will rest in a proper parked position (blade parallel to the edge of the glass).
 - B. Lift the wiper arm extension and push in the retaining latch when the head is fully seated onto the driveshaft.
2. Washer hose, engaging the hose grommet in the lift glass hole.

WIPER BLADE ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 7)

1. Wiper blade assembly.

- A. Insert a screwdriver into the blade retainer slot over the spring.
- B. Pivot the screwdriver so the blade tip presses downward on the retainer spring, releasing the pin of the wiper arm.



Important

- Protect the glass when removing the wiper blade assembly.



Install or Connect (Figure 7)

1. Wiper blade assembly by pressing the pin of the wiper arm assembly into the blade retainer until the pin is engaged.

WIPER BLADE ELEMENT REPLACEMENT



Remove or Disconnect (Figure 7)

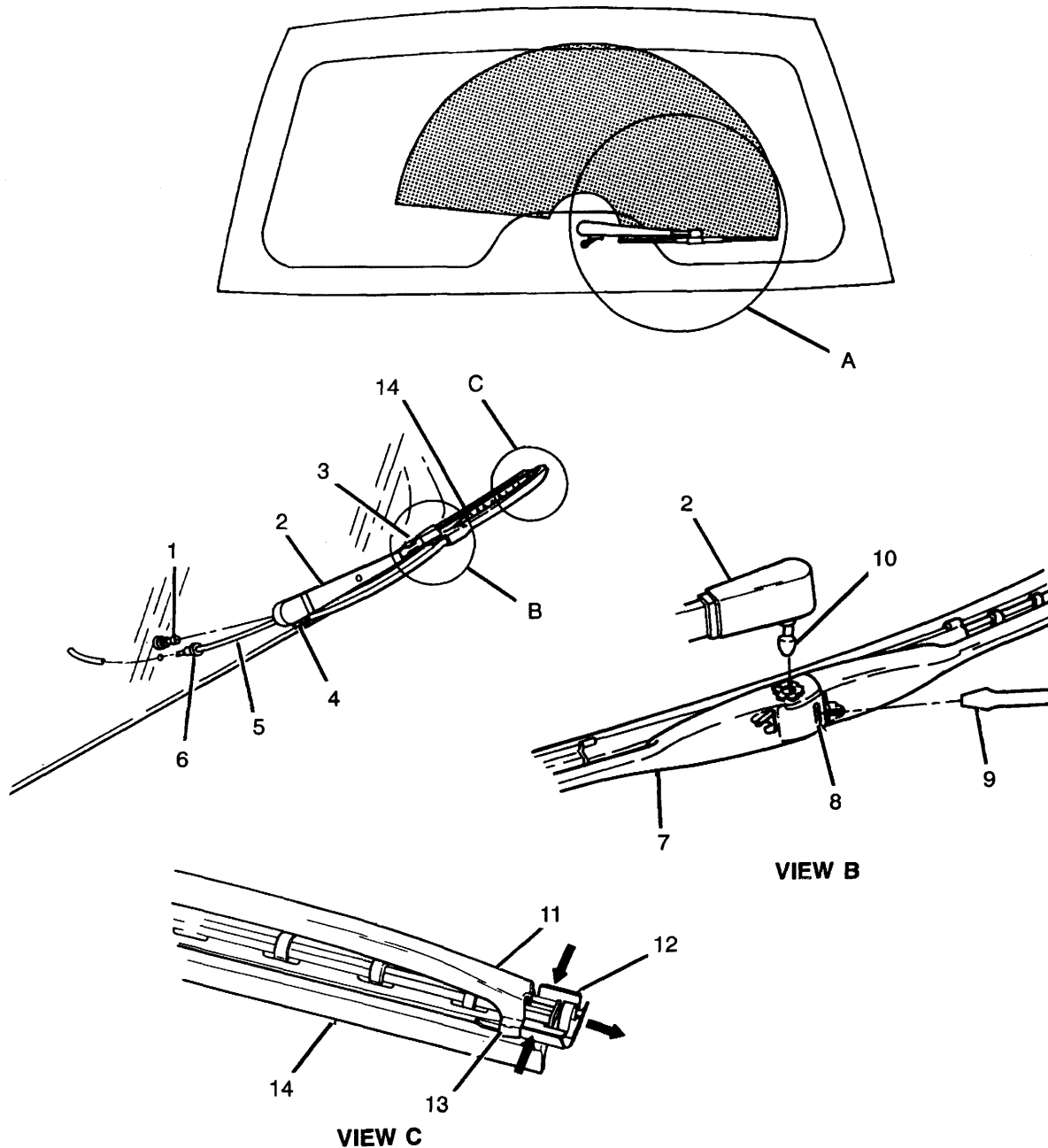
1. Wiper blade element by squeezing the element retainer tabs together, then pull the blade element out.



Install or Connect (Figure 7)

1. Insert the blade element until its retainer is engaged by the outer claw set.

8E2-6 REAR WINDOW WIPER/WASHER SYSTEM



- A. WIPER ARM ASSY. REPLACEMENT
- B. BLADE ASSY. REPLACEMENT
- C. BLADE ELEMENT REMOVAL
- 1. DRIVE SHAFT
- 2. WIPER ARM ASSEMBLY
- 3. WASHER NOZZLE
- 4. RETAINING LATCH
- 5. HOSE
- 6. GROMMET

- 7. WIPER BLADE ASSEMBLY
- 8. RETAINING SPRING
- 9. SCREWDRIVER
- 10. WIPER ARM PIN
- 11. BLADE SUPERSTRUCTURE
- 12. RETAINER
- 13. CLAW SET
- 14. BLADE ELEMENT

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Figure 7—Wiper Arm Assembly, Blade, and Element Replacement

1. MOTOR ASSEMBLY
2. COVER, WIPER MOTOR
3. RETAINER, WIPER MOTOR COVER
4. BOLT
5. CONNECTOR, WIPER HARNESS
6. RETAINER, WIPER MOTOR
7. NUT, 6 N·m (53 LBS. IN.)
8. WASHER
9. SPACER, WIPER MOTOR
10. NUT, 6 N·m (53 LBS. IN.)

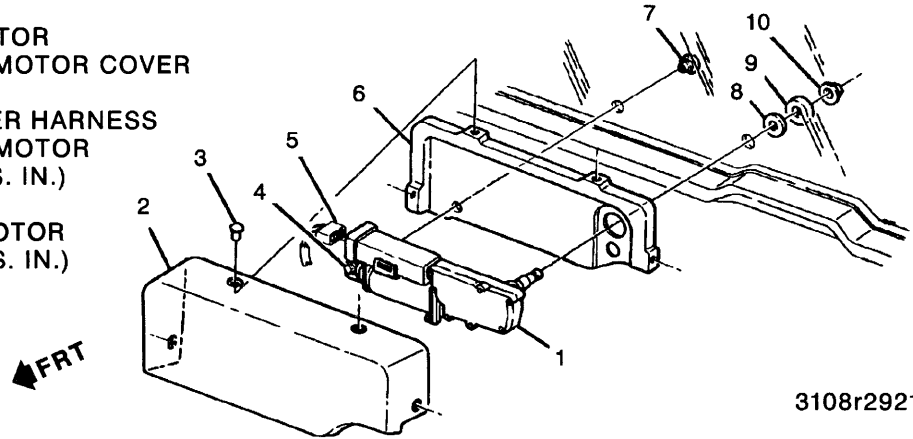


Figure 8—Wiper Motor Assembly Replacement



Important

- Be the sure blade element is secure in all claw sets.
- 2. Check the wipe pattern and compare it to figure 7.

CONTROLLER ASSEMBLY REPLACEMENT



Remove or Disconnect (Figures 3 and 8)

1. Wiper motor assembly. Refer to "Wiper Motor Assembly Replacement."
2. Four retainers and the cover.
3. Wiring harness and wiper motor electrical connectors.
4. Use a screwdriver to pry the locking tabs of the controller assembly free from the slots in the wiper motor bracket.



Install or Connect (Figures 3 and 8)

1. Press the controller assembly into the wiper motor bracket so the locking tabs engage both bracket slots.
2. Wiper motor assembly to the vehicle. Refer to "Wiper Motor Assembly Replacement."

WIPER MOTOR ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 8)

1. Negative battery cable. Refer to SECTION 0A.
2. Wiper arm assembly. Refer to "Wiper Arm Assembly Replacement."
3. Cover from the wiper motor.
4. Electrical connector.
5. Bolt from the wiper motor.
6. Nut, spacer, and washer.
7. Nut.
8. Wiper motor assembly from the vehicle.



Install or Connect (Figure 8)

NOTICE: For steps 2, 3, and 4, refer to "Notice" on page 8E2-1.

1. Wiper motor assembly to the vehicle.
2. Washer, spacer, and nut to the right side of the motor assembly.
3. Nut to the left side of the motor assembly.
4. Bolt to the wiper motor.



Tighten

- Nut to 6 N·m (53 lbs. in.).
- 5. Electrical connector.
- 6. Cover to the wiper motor.
- 7. Wiper arm assembly. Refer to "Wiper Arm Assembly Replacement."
- 8. Negative battery cable.

WIPER/WASHER SWITCH ASSEMBLY REPLACEMENT

Refer to SECTION 8C for Rear Wiper/Washer (Accessory) Switch Replacement.

WASHER PUMP REPLACEMENT



Remove or Disconnect (Figure 9)

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connector and washer hose.
3. Washer pump from the solvent container.



Install or Connect (Figure 9)

1. Washer pump into the solvent container.

8E2-8 REAR WINDOW WIPER/WASHER SYSTEM



Important

- Make sure the new washer pump is pushed all the way into the container seal.
2. Electrical connector and washer hose.
 3. Negative battery cable.

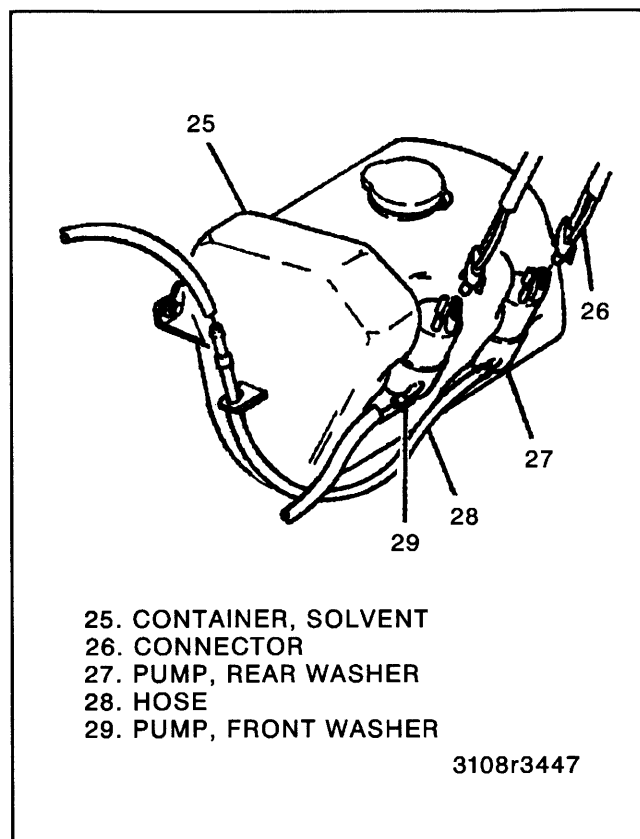


Figure 9—Washer System Components

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

ITEM	N-m	Lbs. Ft.	Lbs. In.
Wiper Motor Mounting Bolt.....	6	—	53
Wiper Motor Mounting Nut.....	6	—	53

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ACCESSORIES

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SECTION 9A

AUDIO SYSTEMS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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AUDIO SYSTEMS

GENERAL DESCRIPTION

The radio receiver is mounted under the instrument panel. The control head is mounted in the instrument panel and connected to the speakers and receiver by an electrical harness (figure 1). The available radio systems are as follows:

1. UP4—AM Radio
2. UM7—AM/FM Stereo, Seek and Scan, Clock
3. UM6—AM/FM Stereo, Seek and Scan, Auto-Reverse Cassette, Clock
4. UX1—AM/FM Stereo, Seek and Scan, Auto-Reverse Cassette, Graphic Equalizer, Clock

HANDLING ELECTROSTATIC DISCHARGE (ESD) SENSITIVE PARTS

Many solid-state electrical components can be damaged by electrostatic discharge (ESD). Some will display a label, but many will not (figure 2).

In order to avoid possibly damaging any components, observe the following:

1. Body movement produces an electrostatic charge. To discharge personal static electricity, touch a ground point (metal) on the vehicle. This should be done any time you:
 - Slide across the vehicle seat.
 - Sit down or get up.
 - Do any walking.
2. Do not touch exposed electric terminals on components with your finger or any tools. Remember, the connector that you are checking might be tied into a circuit that could be damaged by electrostatic discharge.
3. When using a screwdriver or similar tool to disconnect a connector, never let the tool come in contact with or come between the exposed terminals.
4. Never jumper, ground, or use test equipment probes on any components or connectors unless specified in diagnosis. When using test equipment, always connect the ground lead first.
5. Do not remove the solid state component from its protective packaging until you are ready to install the part.

6. Always touch the solid state components package to a ground before opening. Solid state components can also be damaged if:

- They are bumped or dropped.
- They are laid on any metal work benches or components that operate electrically, such as a TV, radio, or oscilloscope.

DESCRIPTION OF OPERATION

AM RADIO (UP4)

Power (PWR) and Volume Knob

Pressing the "PWR-VOL-TONE" knob turns the sound system "On" and "Off." If the radio is "Off," pressing the knob will turn the system "On" and pressing the knob again will turn the system "Off." The ignition lock cylinder must be in the "ACCESSORY" or "RUN" position for the radio to operate.

Turn the knob to the right to increase volume and to the left to decrease volume.

Tone Control Ring

The control ring behind the "PWR-VOL" knob is the tone control. Turn the ring to the right to increase treble and to the left to increase bass.

Set Button (SET)

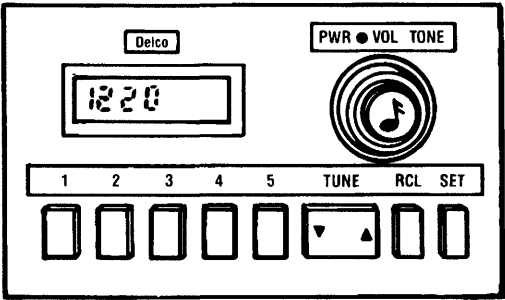
The "SET" push button is used in conjunction with the 5 radio station preset push buttons to program radio frequencies into the memory locations. See "Radio Frequency Preset Buttons" for instructions on presetting AM radio stations.

Radio Frequency Preset Buttons

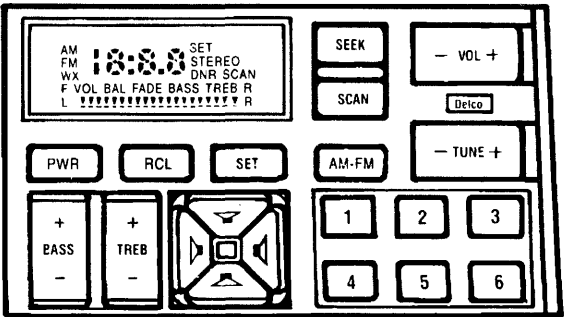
To preset 5 desired AM stations:

1. Tune in the desired station.
2. Press "Set" push button. (The "SET" indicator will light.)
3. Press a station push button. (The "SET" indicator will go out.) The radio will then tune in the selected station whenever that push button is pressed.

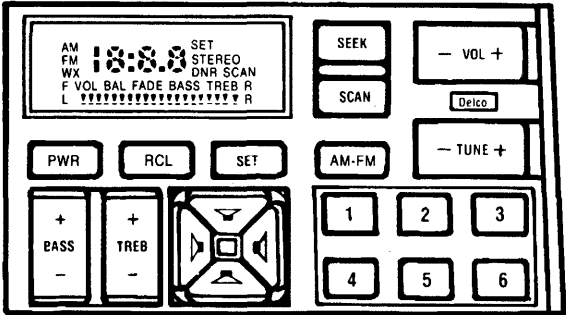
If electrical power is interrupted (by a blown fuse, discharged battery, etc.), the station(s) must be reset.



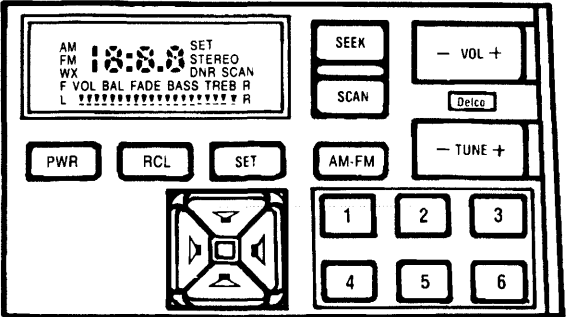
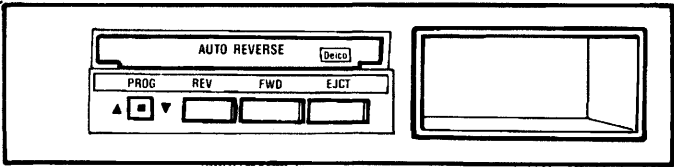
UP4-AM RADIO



UM7-AM/FM STEREO, SEEK AND SCAN, CLOCK



UM6-AM/FM STEREO, SEEK AND SCAN, AUTO REVERSE CASSETTE, CLOCK



UX1-AM/FM STEREO, SEEK AND SCAN, AUTO-REVERSE CASSETTE,
GRAPHIC EQUALIZER, CLOCK

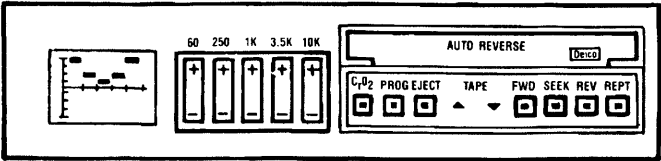


Figure 1—Radio Description



Figure 2—Electrostatic Discharge Symbol

Tune Button

Pressing the "TUNE" push button on the left side will decrease the frequency while pressing the "TUNE" push button on the right side will increase the frequency.

AM/FM STEREO RADIO (UM7, UM6, or UX1)

Power (PWR)

The radio power switch is a push "On"/push "Off" control. If the radio is "Off," pressing the "PWR" push button will turn the system "On" and pressing the "PWR" push button again will turn the system "Off." The ignition lock cylinder must be in the "ACCESSORY" or "RUN" position for the radio to operate. Depressing the "PWR" push button while the ignition is turned "OFF" will not turn the radio "On" but will cause the display to indicate the correct time of day (TOD) for approximately 5 seconds.

Recall (RCL)

If the radio is "On," pressing the "RCL" push button will alternately cause the VF display to change from time of day to radio frequency display.

Band Switching (AM—FM)

Depression of the "AM-FM" push button will change the radio band to AM or FM. When this push button is depressed, the receiver will tune in the frequency last selected on the opposite band and the display will indicate the frequency and "AM" or "FM" mode.

Tuning (TUNE)

Depression of the "TUNE" push button to the right (+) side will increase the AM or FM frequency and pressing the "TUNE" push button to the left (-) will decrease the AM or FM frequency.

Volume (VOL)

Depression of the "VOL" push button on the right (+) side will increase the volume and pressing the "VOL" push button on the left (-) side will decrease the volume.

Seek (SEEK)

Depression of the "SEEK" push button causes the receiver to tune in the next station higher in frequency that may have sufficient signal strength to be listenable. The seeking action terminates at this point.

If the "SEEK" push button is depressed a second time while the tuner is seeking, the tuner will stop seeking and revert to the station that was being received

prior to initiation of the seek command. If one of the preset push buttons is depressed while the tuner is seeking, the receiver will immediately tune in the preset frequency. If the "SET" push button is depressed while the tuner is seeking, "SET" will be enabled for 5 seconds, "SEEK" will be immediately canceled and the receiver will stay tuned where it is.

Scan (SCAN)

Depression of the "SCAN" push button advances the tuning to the station at the next higher frequency and, provided the signal strength exceeds a predetermined level, stops at that station for approximately 5 seconds. If the "SCAN" push button is pressed again during that 5 second period, the receiver will remain tuned to that station. If the "SCAN" push button is not pressed again during that 5 second period, the tuning will advance again and repeat the cycle.

AM Stereo (UX1)

This is an automatic feature on the UX1 model. AM Stereo improves fidelity, but may increase noise on weaker stations. AM stereo does not have the flutter characteristics of FM (caused by tall buildings, hills, etc.). However, it is subject to interference from power lines, neon signs, atmospheric conditions, and unwanted stations. The stereo lamp will come on only when tuned to a clear, noise-free station broadcasting C-QUAM® AM stereo.

Set (SET)

The "SET" push button is a dual function push button. It is used in conjunction with the six radio station preset push buttons to program radio frequencies into the memory locations. Its second function is to set the time of day display (clock). To do this, the "SET" push button is used in conjunction with the "SEEK" and "SCAN" push buttons. Refer to "Clock" for detailed instructions on setting the time of day display. Refer to "Radio Frequency Preset Buttons" for instructions on presetting AM and FM radio stations.

Clock

To set the clock display, the ignition lock cylinder must be in the "ACCESSORY" or "RUN" position and the radio may be "On" or "Off."

The "HOUR" portion of the clock display is set by pressing the "SET" push button and within 5 seconds, pressing the "SEEK" push button until the correct hour is displayed.

The "MINUTE" portion of the clock display is set by pressing the "SET" push button and within 5 seconds, pressing the "SCAN" push button until the correct minute(s) are displayed. If the "SET" push button is pressed while the radio is turned on, the radio frequency will be displayed. The time of day will display when the "SEEK" and "SCAN" push button is pressed.

When the "SET" push button is pressed, the "SET" indicator will appear on the display for approximately 5 seconds. If the "SCAN" or "SEEK" push button is pressed after the "SET" push button is pressed and before the SET indicator goes out, the SET indicator will stay on while the clock is being set and then will go out about 5 seconds after the "SCAN" or "SEEK" push button has been released.

If electrical power is interrupted (by a blown fuse, discharged battery, etc.), the clock will need to be reset after power is restored.

Radio Frequency Preset Buttons

To preset 6 desired AM or FM radio stations:

1. Select AM or FM, as desired, and tune in the desired station.
2. Press "Set" push button. (The "SET" indicator will light.)
3. Press a station push button. (The "SET" indicator will go out.) The radio will then tune in the selected station whenever that push button is pressed.

If electrical power is interrupted (by a blown fuse, discharged battery, etc.), the station(s) must be reset.

Fade and Balance

The "butterfly" fade and balance function push buttons adjust the relative volume between front and rear speakers and between left and right speakers, respectively. Pressing the appropriate end of either push button adjusts the relative volume. For the fade function, the letters "F," "R," the word "FADE," will be lit on the display. Similarly, "L," "R," the word "BAL," will be lit on the display when the balance push button is actuated. After adjustment, the fade (or balance) functions will be displayed for approximately ten seconds, after which the display returns to the volume indication.

Bass/Treble (BASS/TREB) (UM6 or UM7)

The non-equalizer units will have bass and treble controls instead of a graphic equalizer. The bass and treble controls will be rocker switches. When the upper (+) end of the "BASS" switch is depressed, the audio response at the low frequencies is increased. Conversely, when the lower (-) end of the "BASS" switch is depressed, the audio response at the low frequencies is decreased.

Similarly, when the upper (+) end of the "TREB" switch is pressed, the audio response at high frequencies is increased, and when the lower (-) end of the button is pressed, the audio response at high frequencies is decreased.

Loudness

These units contain an auto-loudness feature. This feature boosts low-frequency audio response to compensate for the inability of the ear to hear low-level, low-frequency tones. This compensation varies inversely with the volume control setting. That is, at low volume settings, the low frequencies are boosted much more than at high volume settings.

CASSETTE TAPE PLAYER (UM6 or UX1)

To play a tape, the ignition lock cylinder must be in "ACCESSORY" or "RUN" position and the receiver/tape player must be turned "On." Insert the tape squarely through the door, exposed tape side of the cassette first. When the tape is fully inserted, the AM/FM portion of the radio will turn "Off" and the tape will begin playing.

Fast Forward (FWD)

To advance the tape, press the "FWD" push button. If the end of the tape is reached while in the "FWD" position, the tape will change direction, and play will resume in the opposite direction at normal speed. If the "FWD" or "PROG" push button is depressed while in the "FWD" position, "FWD" will terminate, and play will resume in the original direction at normal speed. "FWD" may also be terminated by depressing "REV," "EJCT," "SEEK," or "RPT." In each case, the chosen function will be activated.

Reverse (REV)

To rewind the tape, press the "REV" push button. If the end of the tape is reached while in the "REV" position, play will resume in the original direction prior to activation of "REV." If the "REV" or "PROG" push button is depressed while in the "REV" position, "REV" will terminate, and play will resume in the original direction at normal speed. "REV" may also be terminated by depressing "FWD," "EJCT," "SEEK," or "RPT." In each case, the chosen function will be activated.

CrO₂ Button (Chrome Dioxide) (UX1)

The "CrO₂" push button is used to select the proper tape bias for the tape to be played. Chrome dioxide tapes use 70 microsecond equalization and normal bias tapes use 120 microsecond equalization. For chrome dioxide (CrO₂) tapes, push the button and the light in the center of the button will illuminate when CrO₂ is activated. For normal bias tapes, push the button so the light is off. The tape bias (normal or high) is printed on the cassette.

Five-Band Equalizer (UX1)

A five-band equalizer is available on the UX1 sound system. The five-band equalizer lets you tailor the frequency response from 60Hz to 10KHz.

The "60" (hertz) and "250" (hertz) push buttons control bass response. The 1K (hertz) push button controls midrange. Treble is controlled by the "3.5K" (hertz) and "10K" (hertz) push buttons.

Press a push button up to increase the frequency range, or down to decrease it. Observe the graphic display to determine the relative bass or treble response.

Seek (UX1)

The UX1 model has the "SEEK" feature. The "SEEK" feature is activated by pressing the "SEEK" push button. When the "SEEK" feature is activated, the tape will rapidly advance to the beginning of the next selection.

NOTE: This feature works by "listening" for a "quiet" section. The "SEEK" feature may stop the tape at a "quiet" section and resume play even though this may not be the beginning of the current or next selection.

Repeat (UX1)

Press the "REPT" push button to repeat a selection on the tape. Pressing the "REPT" push button will cause the tape to reverse to the beginning of the last selection.

9A-6 AUDIO SYSTEMS

Tape Direction Indicators (UM6 and UX1)

The direction the tape is being played or the side of the tape being played is indicated by indicator arrows. When the indicator arrow on the left side is on, the top

side of the tape is being played and the tape direction is to the left. When the indicator arrow on the right side is on, the bottom side of the tape is being played and the tape direction is to the right.

DIAGNOSIS

ENTERTAINMENT AND COMFORT DATA BUS (E&C DATA BUS)

The remote receiver, cassette tape player, and radio control head communicate over a serial communication data bus. Since other GM vehicles using the same communication scheme also include HVAC controls on the same data line, it is also known as the E&C Data Bus (Entertainment and Comfort Data Bus).

The units will generate a carrier voltage that will read with a digital voltmeter as 9 volts DC or above depending on the actual battery voltage. When data is being transmitted, the line is pulled low. If continuous data is being transmitted, such as pressing and holding the "TUNE" button, the DC voltage reading may drop by 1 - 1.5 volts.

One example of communications occurring on the E&C Bus would be the radio tuner "SEEK" function:

1. The "SEEK" push button on the control head is pressed.
2. The control head sends the digital command over the E&C Bus to the remote receiver box.
3. The remote receiver tunes in the next station.
4. The remote receiver reports the new station number to the control head over the E&C Bus.
5. The control head displays the new station.

TECH 1 DIAGNOSIS

The above example demonstrates the interaction between the remote receiver and the control head. An audio system malfunction could be caused by either of these components not able to process the signals correctly (assuming power and grounds have been checked), in addition to speaker, connector, or wiring malfunctions. Due to the complexity of this system, The Tech 1 scan tool with an diagnostic cartridge has been developed to properly diagnose these problems.

The E&C Bus is accessed at pin J of the Data Link Connector (DLC). Through this connection, the Tech 1 may be used to monitor or send commands to the remote receiver. Refer to figures 7, 8, 9, and 10 for available entertainment system Tech 1 tests.

- Tech 1 cartridge TK 03040B "88-93" Body Cartridge

Detailed instructions, cautions, and schematics for Tech 1 E&C Bus diagnosis can also be found in the cartridge user's manual. If unfamiliar with the Tech 1 or if using the E&C cartridge for the first time, take the time to look at the user's manual.

NOISE ENTRY

FRONTWAY NOISE

Any noise which can be eliminated by unplugging the antenna from the back of the radio receiver.

Some Causes:

- Poor grounding or missing grounds of: the antenna base, the receiver, some electrical components, and body parts.
- Defective or marginal components (relays, switches, and electric motors).
- Something near the antenna lead-in or corrosion at lead-in connections.

Solutions:

- Always verify grounding first. If more than one component interferes, a poor ground probably exists.
- Pinpoint the source: suppress, shield, or replace.
- Reroute noisy wires if necessary.

SIDEWAY NOISE

Any noise which is reduced or eliminated when slowly moving the audio component from its mounted location.

Some Causes:

- Noisy wiring or harnesses behind or on top of the audio component or antenna lead-in.

Solutions:

- Suppress or shield the noisy wire or harness or reroute it.
- Shield the radio case.

BACKWAY NOISE

Any noise that can be heard at minimum volume.

Some Causes:

- Poor grounding of the radio.
- Unsuppressed electrical components.
- Poorly routed wires.
- Defective suppression of components.

Solutions:

- Suppression (capacitors, etc.) can be installed at the source (preferable), the radio, or both.
- Switch pops are backway noise and are best suppressed using capacitors.
- Squeals and buzzes are best suppressed using filter packages.

HARNESS RELATED NOISE

Some Causes:

- Broken, pinched, or shorted audio wires.
- Screw through wire harness.
- Faulty shield wires.

Solutions:

- Localize problem to one side, front or back speaker location. Preferably done by using the fade and balance controls; if not, try reversing the speaker leads at the radio connector.

- Check wiring for defects, breaks, pinches, or shorts.
- Check wiring near known noisy components.

Many conditions that affect radio operation may be corrected without removing the radio or tape player from the vehicle. Verify the condition and follow the diagnosis charts to isolate and determine the cause of the problem (figures 3 through 19).

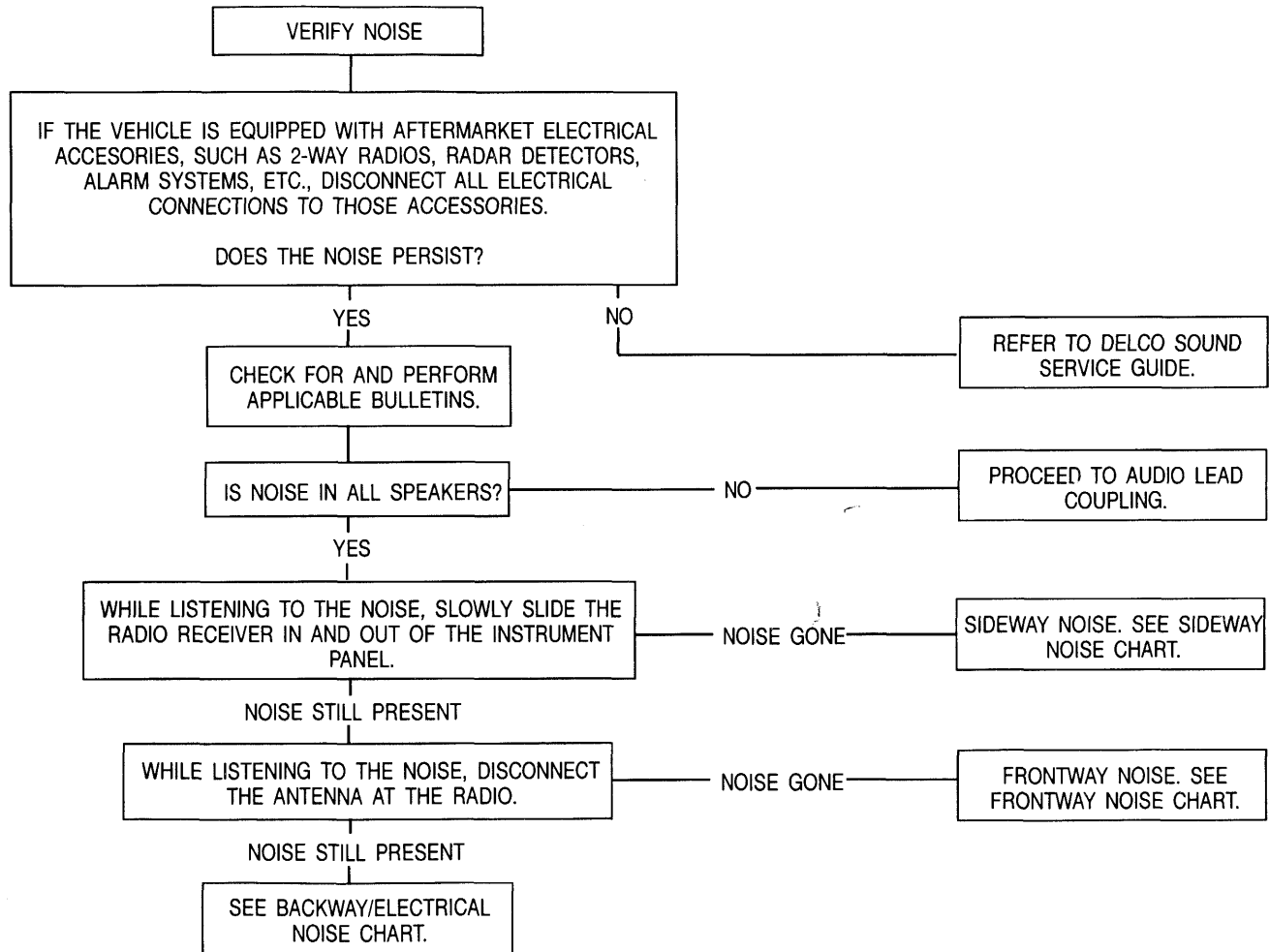
Because radio service problems are usually corrected at authorized Warranty Repair Stations, the tendency is to remove the radio or tape player when a problem is reported, without any preliminary diagnosis. A large number of radios received by the Warranty Repair Sta-

tions are found to be okay. This indicates that the trouble could have been corrected without removing the radio. The inconvenience to an owner of having to drive without a radio while it is at a Warranty Repair Station can frequently be avoided if the diagnosis is used before removing the radio for repairs.

If possible, determine from the owner the exact nature of the radio problem as an aid to diagnosis. Knowing whether the condition is intermittent or constant, whether it occurs with the engine off or running, with the vehicle stationary or moving, will help pinpoint the problem. Also, check that the antenna is functioning properly and that the lead-in is not at fault. Refer to "Antenna Diagnosis" later in this section.

NOISE CHART

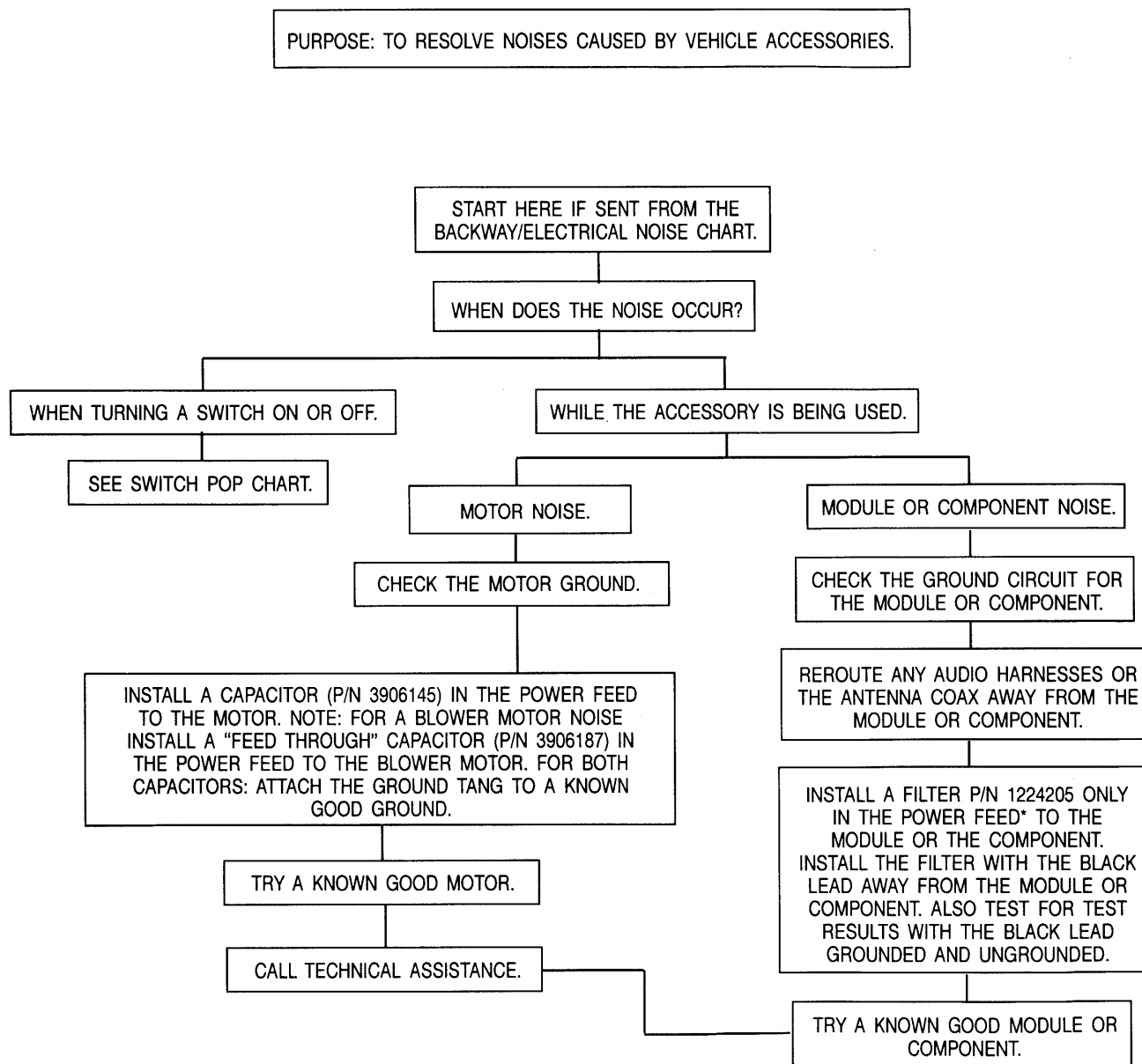
PURPOSE: TO DETERMINE HOW THE NOISE HAS ENTERED THE AUDIO SYSTEM.
THIS CHART ONLY APPLIES TO NOISES ELECTRICALLY GENERATED BY THE SPEAKERS.



C0226

Figure 3—Noise Chart

ACCESSORY NOISE

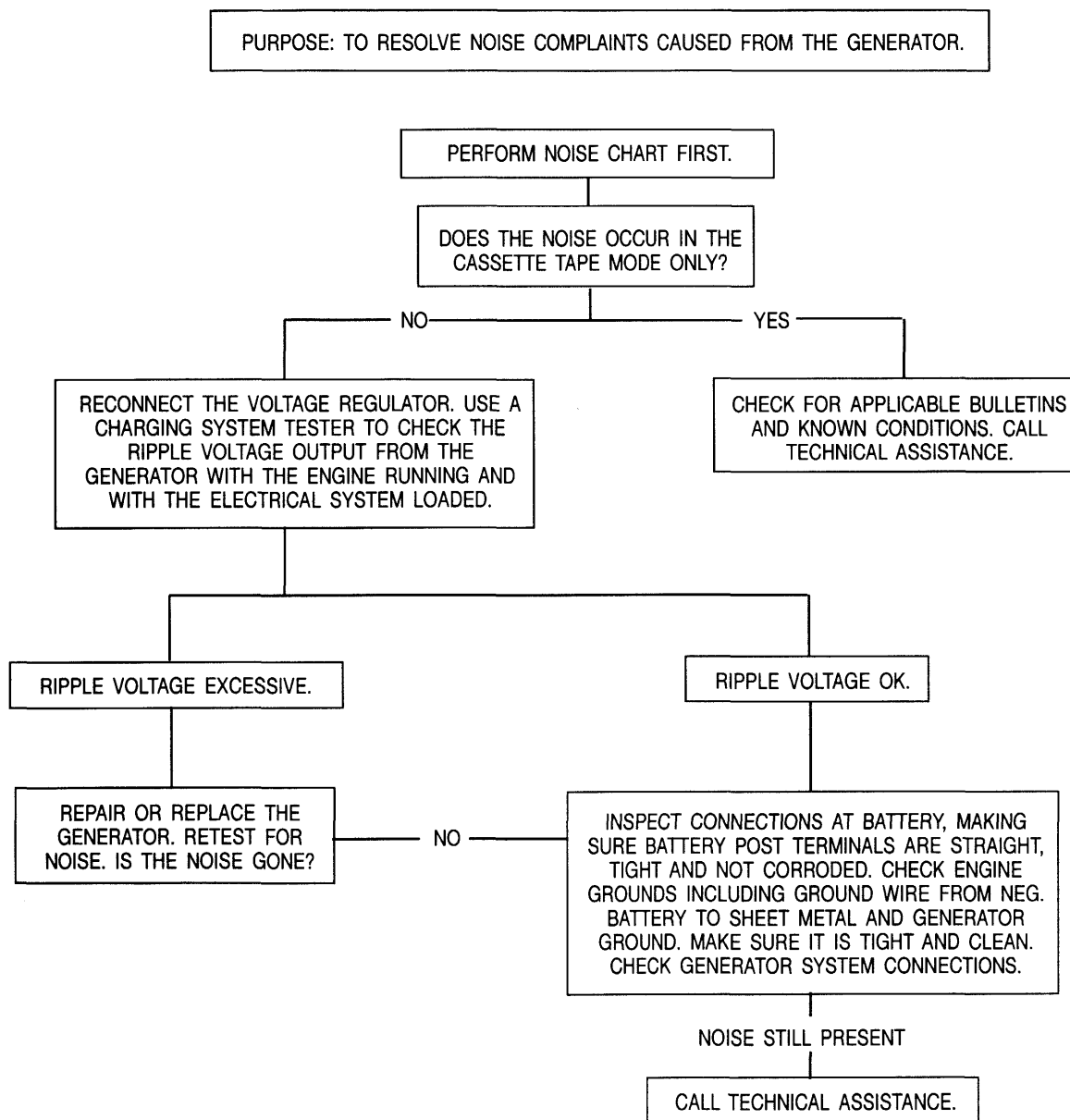


*ADDING SUPPRESSION TO A SIGNAL LEAD MAY CAUSE A CHECK ENGINE LIGHT OR MALFUNCTION OF COMPONENT.

C0227

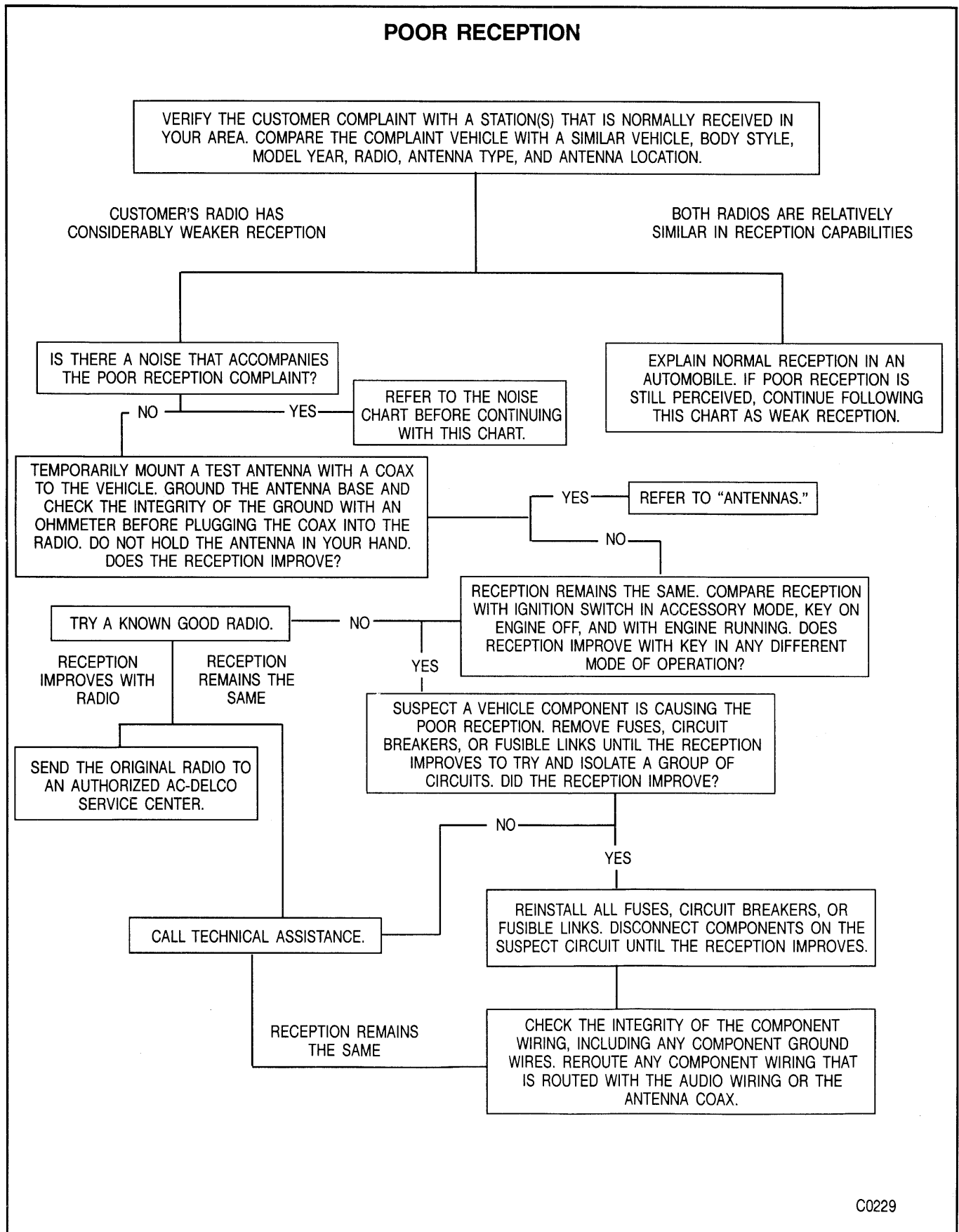
Figure 4—Accessory Noise

GENERATOR NOISE



C0228

Figure 5—Generator Noise



C0229

Figure 6—Poor Reception

RADIO SYSTEM INOPERATIVE

PURPOSE: TO IDENTIFY THE DESCRIPTION OF AN INOP COMPLAINT WHICH MAY CONSIST OF ANY VARIATIONS OF THE DISPLAY, AUDIO OUTPUT OR CONTROL OF FUNCTIONS.

VERIFY COMPLAINT. WITH IGNITION OFF, REMOVE IGNITION AND BATTERY FUSES TO RADIO. CHECK CONDITION OF FUSES AND REINSTALL AFTER 1 TO 2 MINUTES. DOES THE RADIO NOW FUNCTION PROPERLY?

YES

NO

1. CHECK BATTERY FOR STATE OF CHARGE AND ALL CONNECTIONS FOR GOOD CONTINUITY.
2. CHECK ALL GROUNDS.
3. IF PROBLEM REOCCURS CALL TECHNICAL ASSISTANCE.

REPAIR WIRING AND RECHECK SYSTEM.

YES

1. CHECK CONNECTIONS AT BACK OF RADIO. CHECK FOR VOLTAGE AT BATTERY AND IGNITION INPUTS.
2. CHECK THE RADIO GROUND.
3. IF DATA LINE IS PRESENT IN RADIO HARNESS, DISCONNECT.

DOES RADIO NOW FUNCTION PROPERLY?

YES

NO

MAKE NECESSARY REPAIRS TO AFFECTED HARNESS OR CONNECTOR.

TRY A KNOWN GOOD RADIO. DOES THE RADIO SYSTEM NOW FUNCTION PROPERLY?

SEE NOISE AND RECEPTION CHARTS.

NO

YES

SEND THE RADIO TO AN AUTHORIZED A/C DELCO REPAIR CENTER.

DOES THE SYSTEM HAVE A REMOTE UNIT (E.G.) CONTROL HEAD, RECEIVER BOX, TAPE, EQ., OR CD?

NO

IS THERE A DISPLAY ON THE RADIO?

NO

YES

CHECK FOR A SHORT TO GROUND ON THE DIM LINE. IS THERE A SHORT?

IS THERE AN AUDIO OUTPUT?

YES

NO

DISCONNECT AUDIO LEADS FROM THE RADIO. MEASURE THE AC VOLTAGE ACROSS THE SPEAKER OUTPUT TERMINALS. INCREASE THE VOLUME TO MAX VOLUME. IS 3-5 VOLTS AC MEASURED?

NO

YES

WITH AN OHM METER CHECK THE AUDIO LEADS FROM THE RECEIVER TO EACH SPEAKER AND CHECK EACH SPEAKER.

A

USING THE TECH 1 SCAN TOOL SELECT "IDENTIFY COMPONENTS". DO ALL COMMUNICATING UNITS IDENTIFY THEMSELVES? (SOME UNITS WILL NOT ID, REFER TO TECH 1 SCAN TOOL DIAGNOSTICS).

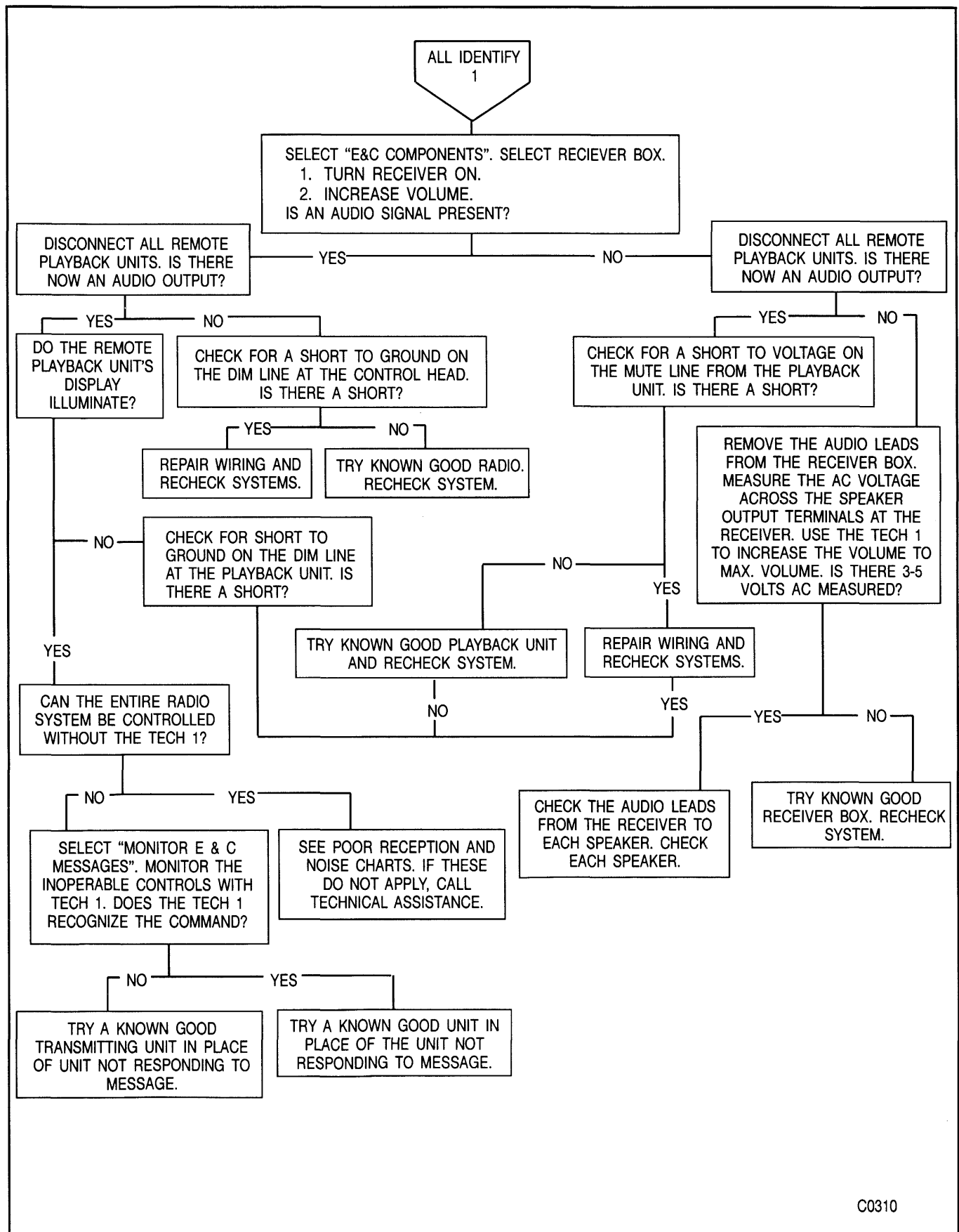
ALL IDENTIFY
1

SOME IDENTIFY
2

NONE IDENTIFY
3

C0230

Figure 7—Radio System Inoperative



C0310

Figure 8—Radio System Inoperative (Cont.)

9A-14 AUDIO SYSTEMS

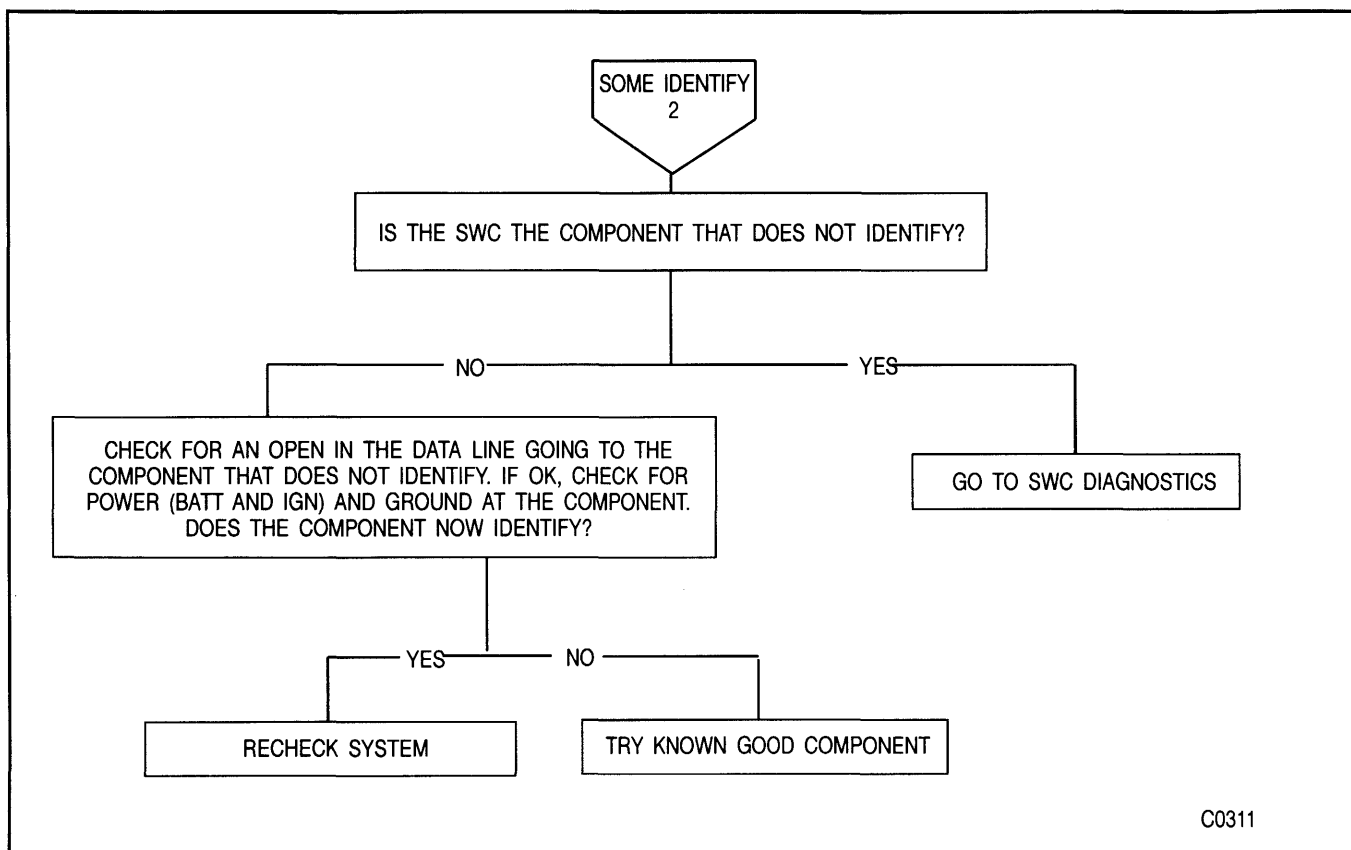


Figure 9—Radio System Inoperative (Cont.)

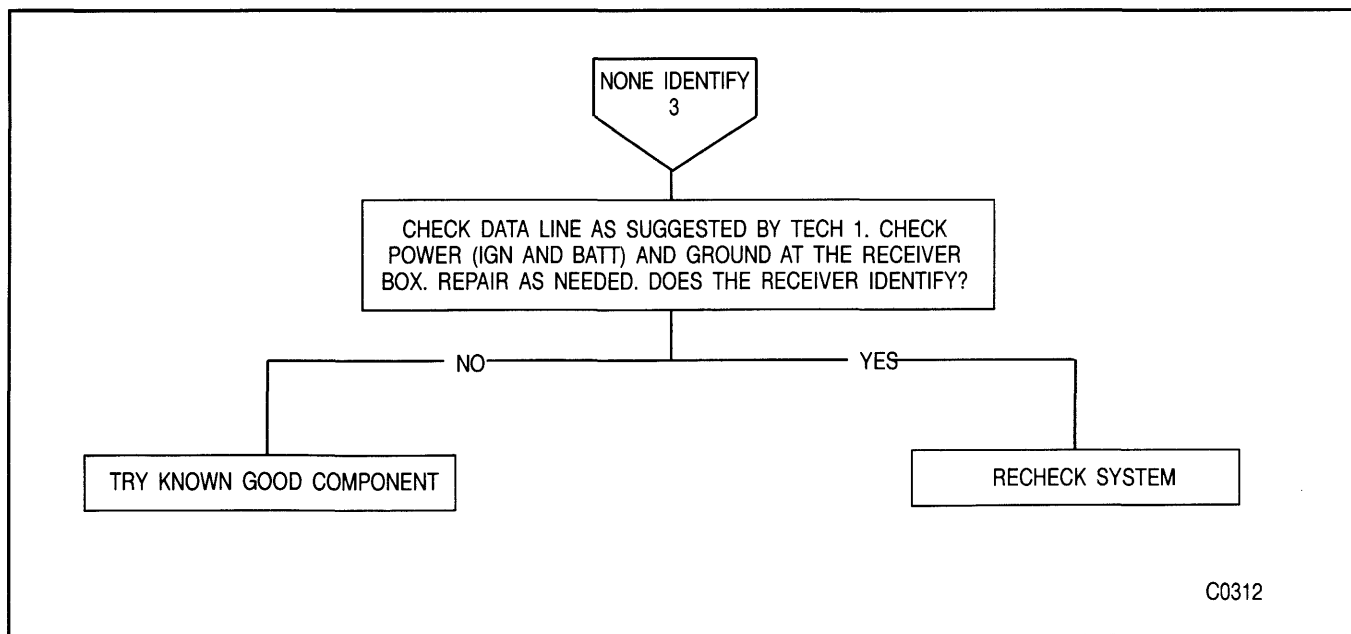
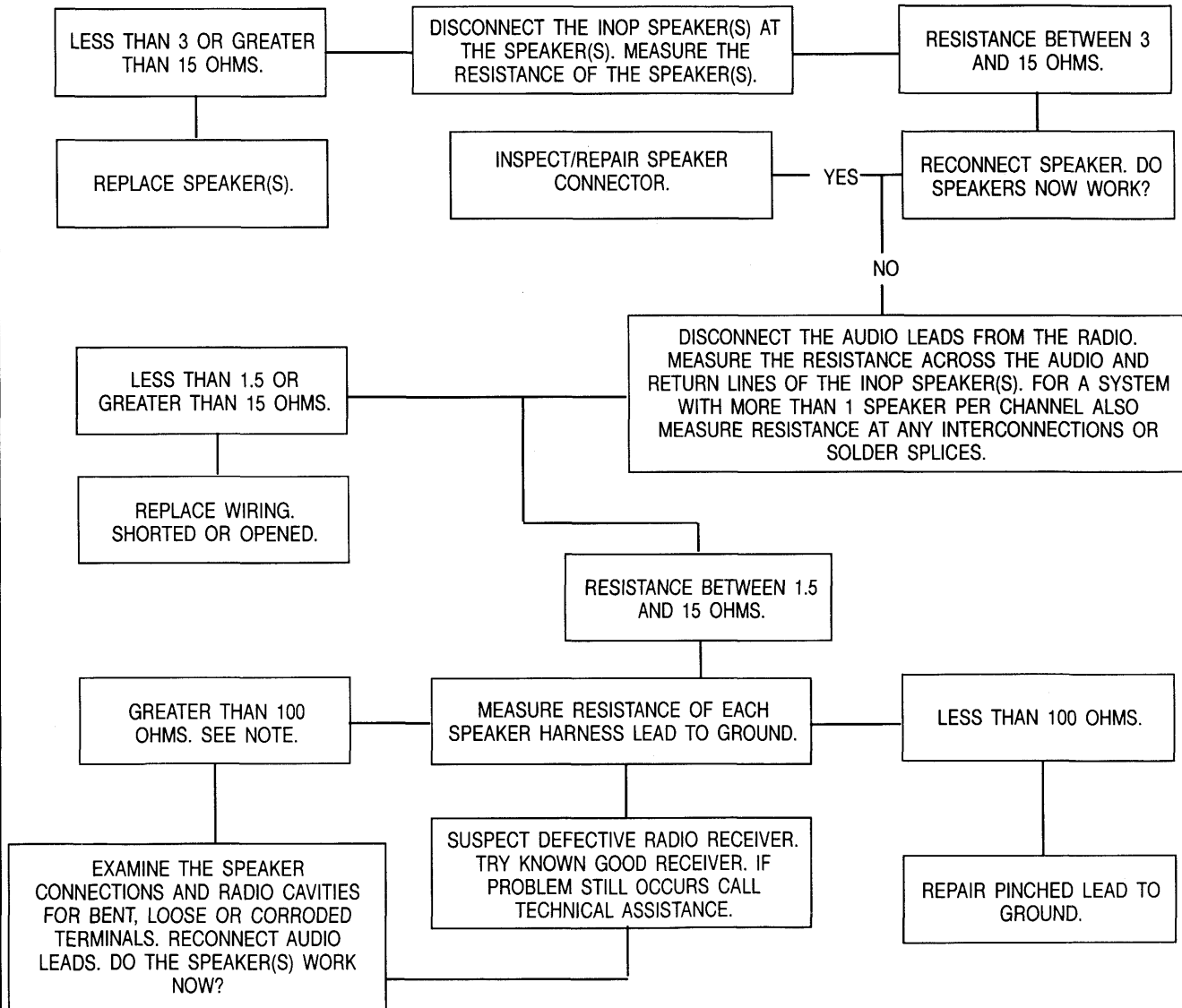


Figure 10—Radio System Inoperative (Cont.)

SPEAKER(S) INOPERATIVE

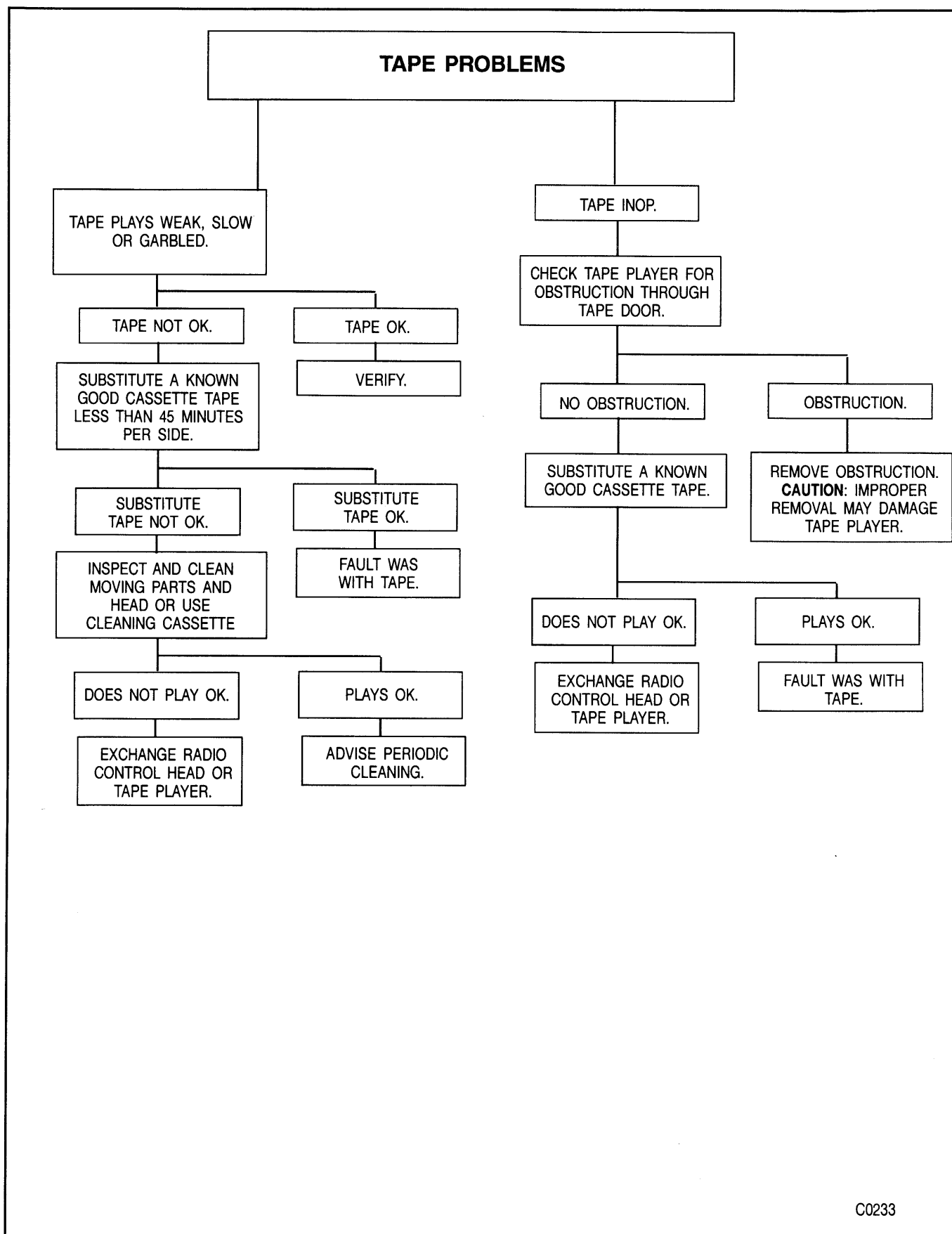
THIS CHART IS APPLICABLE FOR RADIOS WITH 4 CHANNELS. EACH CHANNEL MAY HAVE MORE THAN ONE SPEAKER. IF AN EXTERNAL AMPLIFIER IS USED IN THIS SYSTEM, REFER TO DEALER SERVICE MANUAL FOR DIAGNOSIS.



NOTE: ANY RESISTANCE MEASUREMENT EXCEPT INFINITE BETWEEN THE SPEAKER LEADS AND GROUND SHOULD BE INVESTIGATED FOR A SHORT TO GROUND.

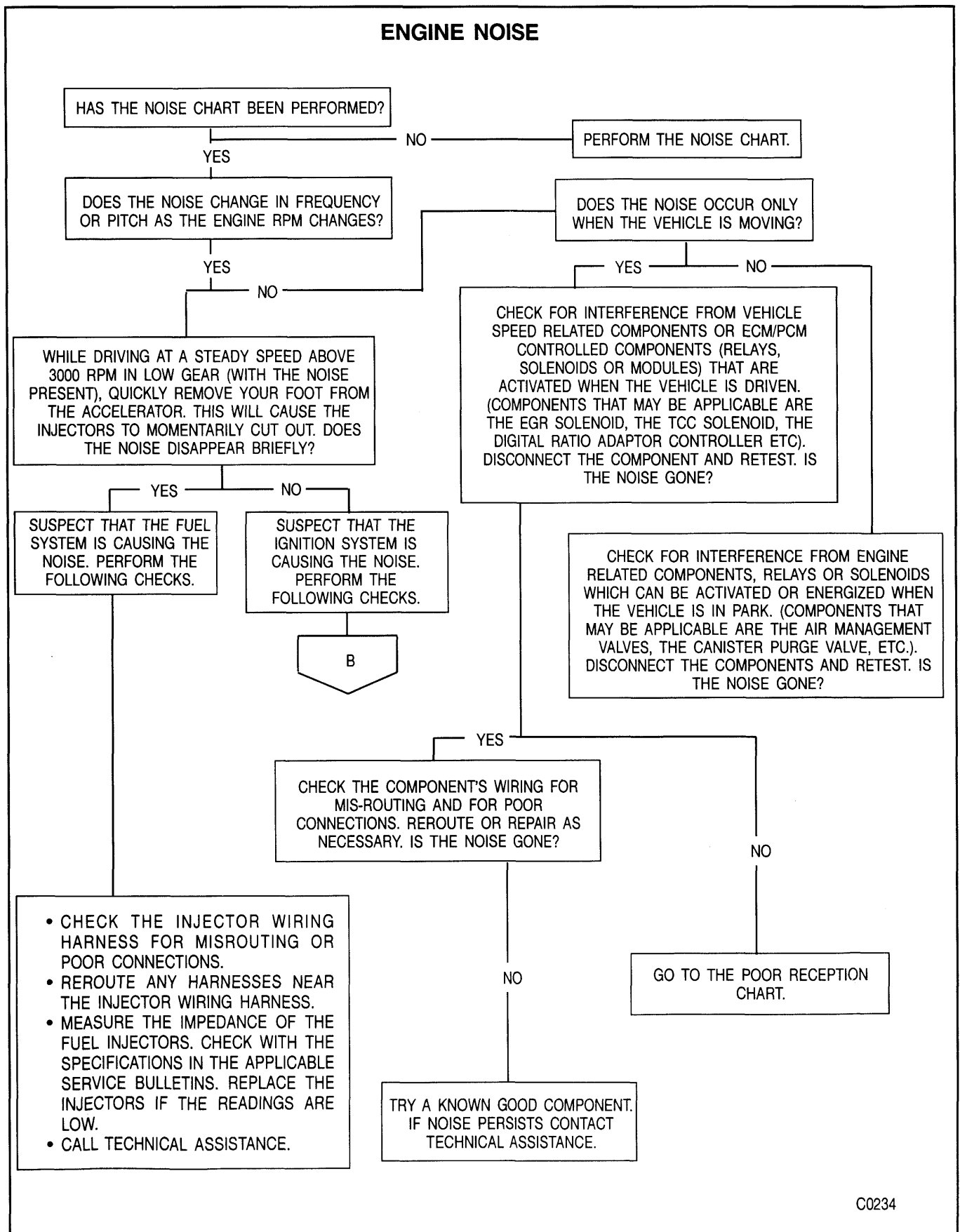
C0231

Figure 11—Speaker(s) Inoperative



C0233

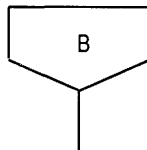
Figure 12—Tape Problems



C0234

Figure 13—Engine Noise

ENGINE NOISE (CONTINUED)

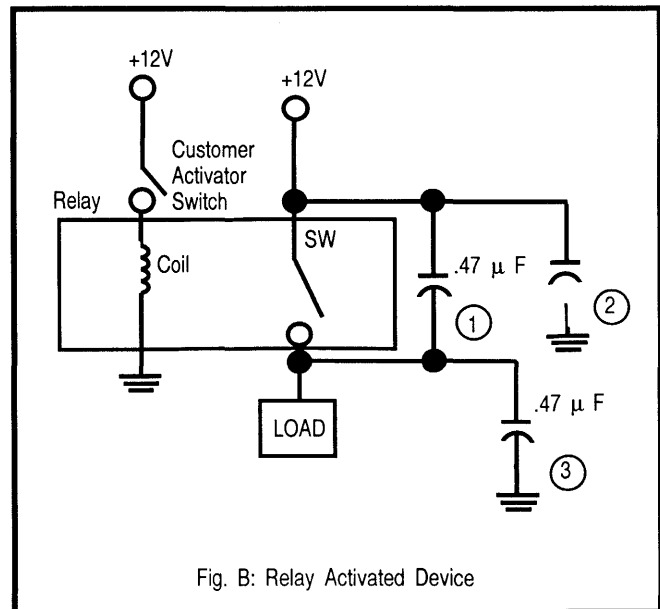
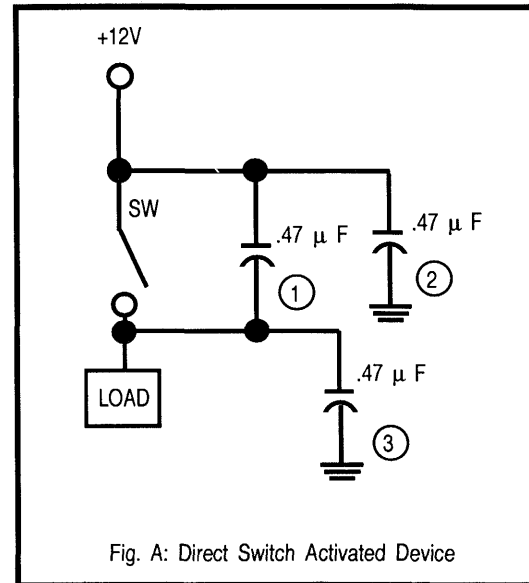
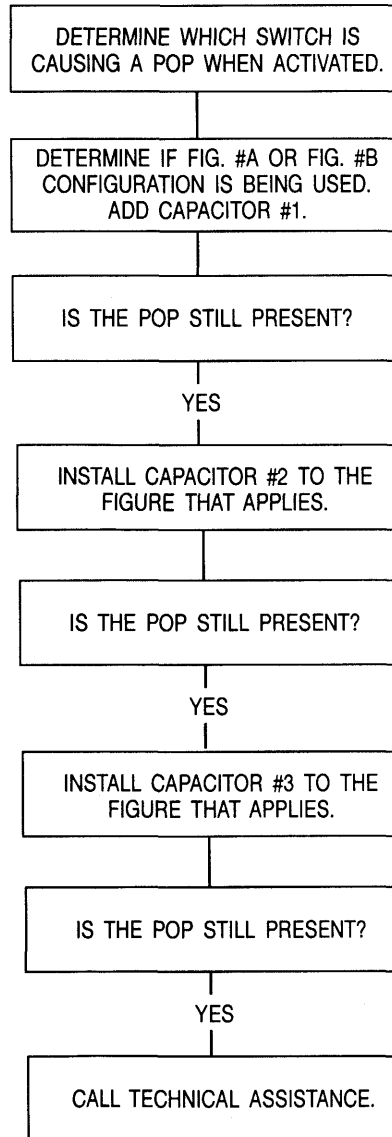


- CHECK FOR CLEAN AND TIGHT BATTERY CONNECTIONS INCLUDING THE BATTERY GROUNDS.
- CHECK FOR LOOSE OR DEFECTIVE SPARK PLUG WIRES.
- CHECK FOR DEFECTIVE SPARK PLUGS OR THE WRONG SPARK PLUG GAP.
- WITH THE ENGINE RUNNING, HAVE AN ASSISTANT LISTEN TO THE RADIO AND CHECK FOR CHANGES IN THE NOISE WHILE MOVING THE SPARK PLUG WIRES. IF THE NOISE CHANGES, CHECK FOR PROPER SPARK PLUG WIRE ROUTING. REFER TO SECTION 6D4 FOR THE CORRECT ROUTING. FOLLOW THE SAME PROCEDURE FOR CONDUCTIVE VACUUM HOSES THAT MAY BE CONDUCTING NOISE TO THE RADIO. CONDUCTIVE VACUUM HOSES USUALLY DO NOT HAVE A STRIPE ON THEM.
- CHECK AND CLEAN SPARK PLUG WIRE BOOTS FOR EXCESSIVE SILICON GREASE.
- CLEAN THE ROTOR AND DISTRIBUTOR CAP OF ANY EXCESS CARBON BUILD-UP.
- CHECK THE DISTRIBUTOR CAP FOR CRACKS, EXCESSIVE WEAR OR EXCESSIVE PLAY OF THE CARBON CENTER CONTACT.
- CHECK THE ROTOR FOR CRACKS, EXCESSIVE WEAR, OR A BURNED THROUGH CONDITION.
- CHECK THE RESISTANCE OF ALL GROUNDS WITH THE NEGATIVE BATTERY CABLE DISCONNECTED. REPAIR OR REPLACE IF RESISTANCE IS EXCESSIVE.
- FOR AN HEI SYSTEM WITH A REMOTE IGNITION COIL:
 1. CHECK THE CONDITION OF THE SECONDARY IGNITION WIRE TO THE COIL. REPAIR OR REPLACE AS NEEDED.
 2. CHECK THE IGNITION COIL FOR A BURNT CONDITION.
 3. CHECK FOR AN OPEN SECONDARY IGNITION COIL.
 4. INSTALL A 0.5 UFD CAPACITOR (P/N 3906145) IN THE POWER FEED TO THE COIL.
- CALL TECHNICAL ASSISTANCE.

C0235

Figure 14—Engine Noise (Cont.)

SWITCH POP



C0236

Figure 15—Switch Pop

SIDEWAY NOISE

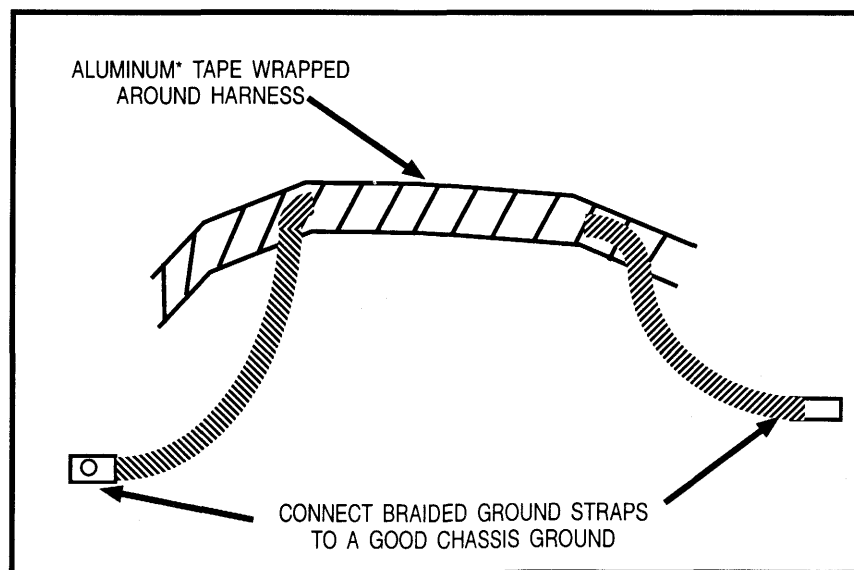
PURPOSE: TO RESOLVE NOISE COMPLAINTS THAT ENTER THE RADIO THROUGH ITS CHASSIS.

WHERE POSSIBLE, REROUTE VEHICLE WIRING HARNESSES AWAY FROM THE RADIO RECEIVER.

IF UNABLE TO REROUTE A HARNESS, SHIELD THE HARNESS BY WRAPPING IT WITH ALUMINUM TAPE. BE SURE NOT TO LEAVE GAPS BETWEEN THE WRAPS OF THE TAPE. GROUND EACH END OF THE SHIELD BY TAPING A BRAIDED GROUND STRAP TO IT AND ATTACHING THE STRAPS TO A GOOD CHASSIS GROUND.

IF NOISE PERSISTS, REMOVE THE RECEIVER HARNESS GROUND WIRE AND ATTACH A BRAIDED GROUND STRAP TO THE RECEIVER CASE. CONNECT THE OTHER END OF THE STRAP TO A GOOD CHASSIS GROUND.

IF NOISE PERSISTS, PROCEED TO BACKWAY/ELECTRICAL NOISE CHART.



*ALUMINUM TAPE WILL ONLY PROTECT AGAINST ELECTRICAL INTERFERENCE.

C0237

Figure 16—Sideway Noise

FRONTWAY NOISE

PURPOSE: TO RESOLVE NOISE COMPLAINTS THAT ENTER THE RADIO THROUGH THE ANTENNA SYSTEM.

TEST ANTENNA. REFER TO "ANTENNAS."

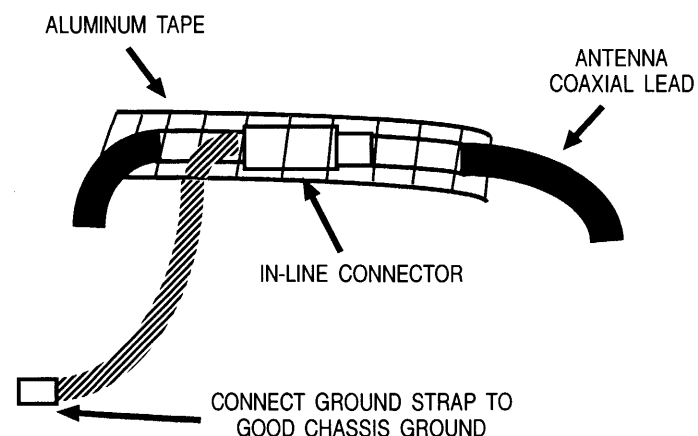
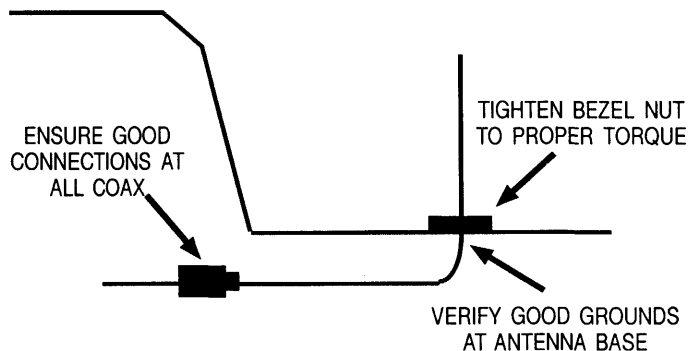
CHECK ALL COAX CONNECTORS, PARTICULARLY ON MULTI-PIECE ANTENNA COAXES, FOR CORROSION, TIGHTNESS. TRY RE-ROUTING THE COAX AWAY FROM OTHER ELECTRICAL COMPONENTS AND THEIR WIRING.

IF NECESSARY, CLEAN THE CONNECTORS AND WRAP THEM WITH ALUMINUM TAPE. ATTACH WITH THE TAPE A BRAIDED GROUND STRAP CONNECTED TO A GOOD CHASSIS GROUND.

CHECK ALL ANTENNA MOUNTS FOR GOOD GROUNDS. ENSURE ALL MOUNTING SCREWS ARE CLEAN AND TIGHT. IF POWER ANT. MAKE SURE UPPER BRACKET IS TIGHTENED BEFORE LOWER BRACKET IS SECURED. ALSO TIGHTEN THE ANTENNA BEZEL NUT TO THE PROPER TORQUE.

IF NOISE PERSISTS, REMOVE THE RECEIVER HARNESS GROUND WIRE AND ATTACH A BRAIDED GROUND STRAP TO THE RECEIVER CASE. CONNECT THE OTHER END OF THE STRAP TO A GOOD CHASSIS GROUND.

IF NOISE PERSISTS, PROCEED TO BACKWAY/ELECTRICAL NOISE CHART.

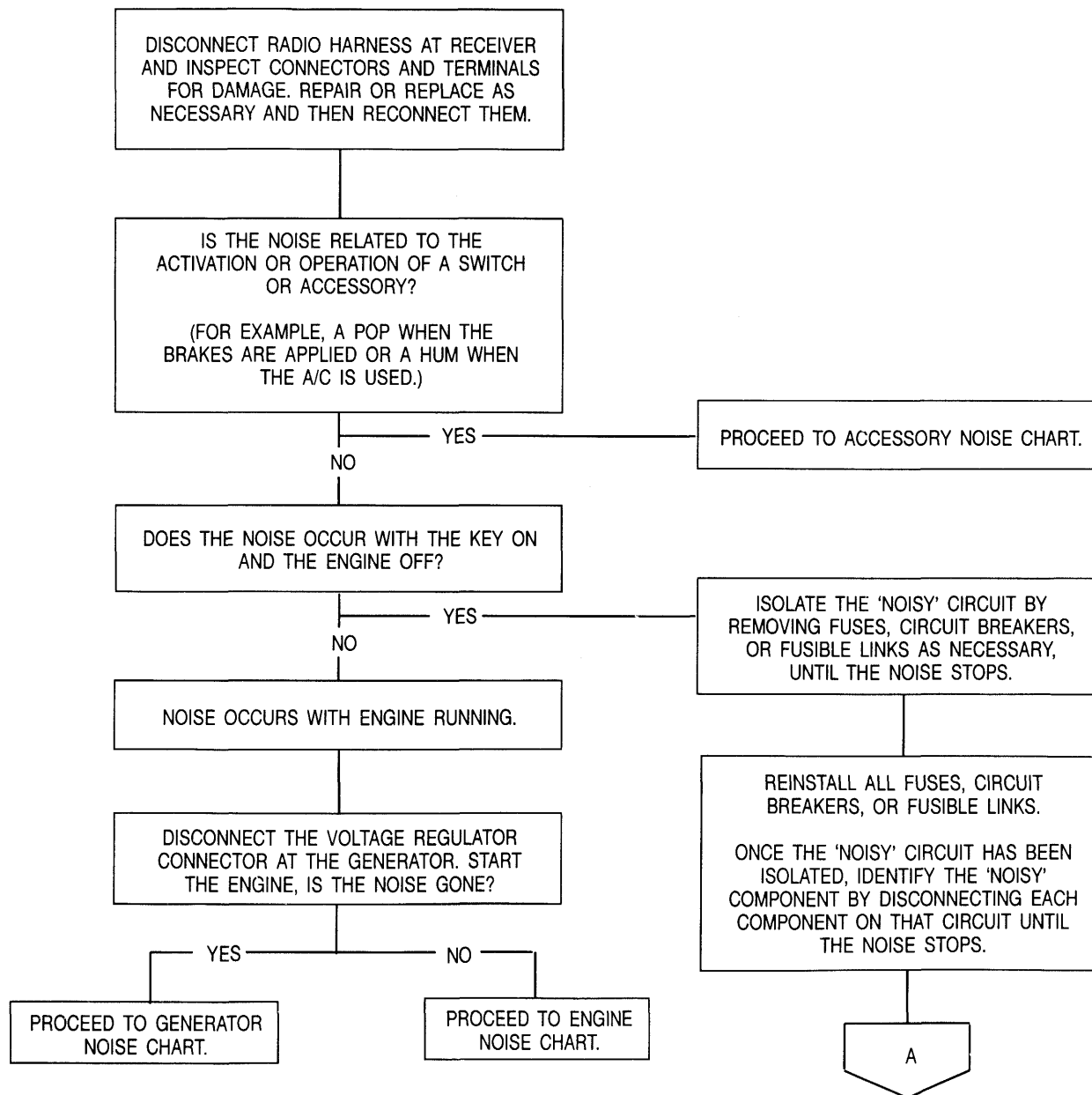


C0238

Figure 17—Frontway Noise

BACKWAY/ELECTRICAL NOISE

PURPOSE: TO RESOLVE NOISE COMPLAINTS CAUSED BY ELECTRICAL SYSTEM INTERFERENCES.



C0239

Figure 18—Backway/Electrical Noise

BACKWAY/ELECTRICAL NOISE (CONTINUED)

A

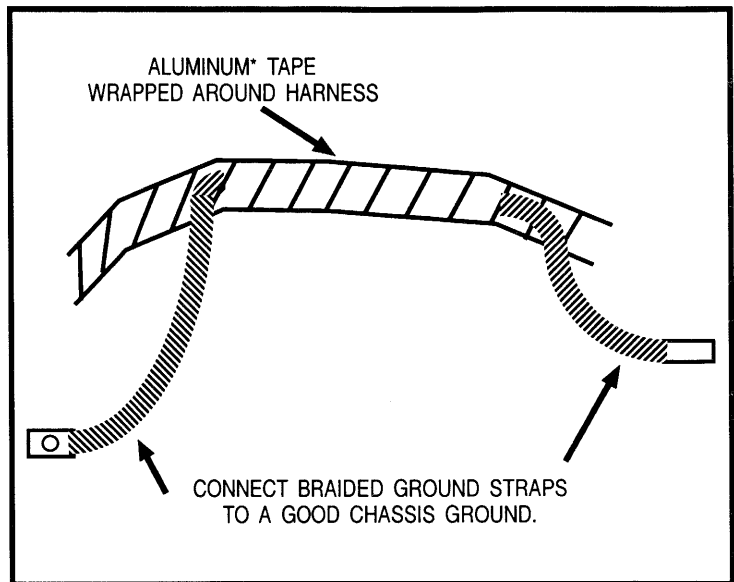
REROUTE RADIO SYSTEM HARNESSES AWAY FROM OTHER VEHICLE WIRING AND ELECTRICAL COMPONENTS. REMOVE RADIO SYSTEM WIRING FROM HARNESSES WHEN BUNDLED WITH OTHER VEHICLE WIRING.

ESTABLISH A NEW COMPONENT GROUND IF CURRENTLY SHARED WITH THE AUDIO SYSTEM. IF ROUTED TOGETHER WITH AUDIO SYSTEM WIRING, SEPARATE AND SHIELD THE COMPONENT WIRING. THE WIRING CAN BE SHIELDED BY WRAPPING IT WITH ALUMINUM* TAPE. BE SURE NOT TO LEAVE GAPS BETWEEN THE WRAPS OF THE TAPE. GROUND EACH END OF THE SHIELD BY TAPING A BRAIDED GROUND STRAP TO IT AND ATTACHING THE STRAPS TO A GOOD CHASSIS GROUND.

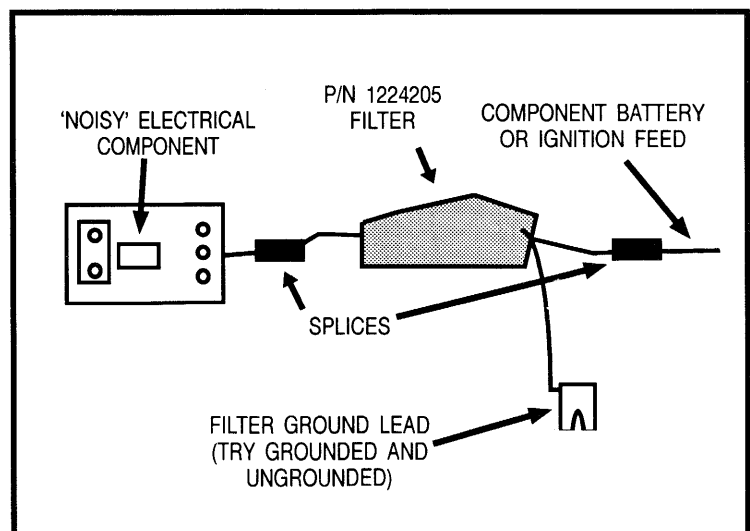
INSTALL A FILTER PACKAGE P/N 1224205, ONLY ON THE POWER FEEDS TO THE 'NOISY' COMPONENT. INSTALL THE FILTER WITH THE BLACK LEAD AWAY FROM THE COMPONENT. ALSO TEST FOR BEST RESULTS WITH THE BLACK LEAD GROUNDING AND UNGROUNDING.

IF THE NOISE PERSISTS, REMOVE THE RADIO GROUND WIRE AND ATTACH A BRAIDED GROUND STRAP TO THE RADIO CASE. CONNECT THE OTHER END TO A GOOD CHASSIS GROUND.

CONTACT TECHNICAL ASSISTANCE.



*ALUMINUM TAPE WILL ONLY PROTECT AGAINST ELECTRICAL INTERFERENCE.



C0240

Figure 19—Backway/Electrical Noise (Cont.)

ON-VEHICLE SERVICE

RADIO RECEIVER

↔ Remove or Disconnect (Figure 20)

1. Negative battery cable. Refer to SECTION 0A.
2. Steering column filler panel. Refer to SECTION 10A4.
3. Ashtray. Refer to SECTION 10A4.
4. Electrical connectors, as necessary.
5. Screw (2) from receiver bracket (4).
6. Nut (7).
7. Receiver (8) from center support (6).
8. Nut (3) from receiver bracket (4).
9. Bracket (4) and clip (5) from receiver (8).

↔ Install or Connect (Figure 20)

1. Clip (5) and bracket (4) to receiver (8).

NOTICE: For steps 2, 4, and 5, refer to "Notice" on page 9A-1.

2. Nut (3) to receiver bracket (4).



Tighten

- Nut (3) to 2.5 N.m (22 lbs. in.).

3. Receiver (8) to center support (6).
4. Nut (7).



Tighten

- Nut (7) to 2.5 N.m (22 lbs. in.).

5. Screw (2) to receiver bracket (4).



Tighten

- Screw (2) to 1.9 N.m (17 lbs. in.).

6. Electrical connectors, as necessary.
7. Ashtray. Refer to SECTION 10A4.

8. Steering column filler panel. Refer to SECTION 10A4.
9. Negative battery cable.
 - Check circuit operation.

CONTROL HEAD

↔ Remove or Disconnect (Figures 21 and 22)

1. Negative battery cable. Refer to SECTION 0A.
2. Instrument panel bezel. Refer to SECTION 10A4.
3. HVAC control. Refer to SECTION 1A or 1B.
4. Screws (11).
5. Control head (10).
6. Electrical connectors and antenna cable, as necessary.

↔ Install or Connect (Figures 21 and 22)

1. Electrical connectors and antenna cable, as necessary.
2. Control head (10).

NOTICE: Refer to "Notice" on page 9A-1.

3. Screws (11).



Tighten

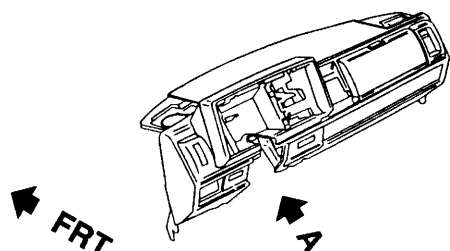
- Screws (11) to 1.9 N.m (17 lbs. in.).

4. HVAC control. Refer to 1A or 1B.
5. Instrument panel bezel. Refer to SECTION 10A4.
6. Negative battery cable.
 - Check circuit operation.

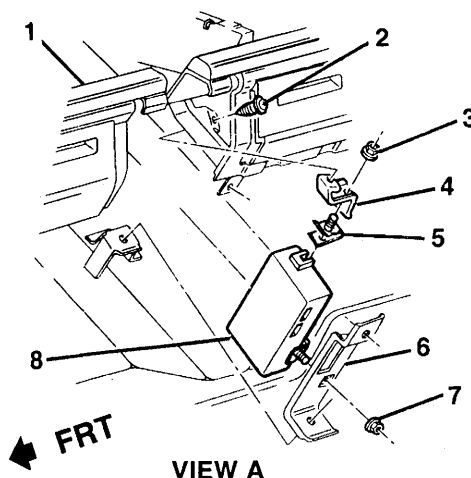
TAPE PLAYER

↔ Remove or Disconnect (Figure 23)

1. Negative battery cable. Refer to SECTION 0A.
2. Accessory trim plate. Refer to SECTION 10A4.
3. Electrical connectors, as necessary.



1. PANEL, INSTRUMENT
2. SCREW, RADIO RECEIVER BRACKET MONTING
3. NUT, RADIO RECEIVER BRACKET MOUNTING
4. BRACKET, RADIO RECEIVER
5. CLIP, RADIO MOUNTING
6. SUPPORT, INSTRUMENT PANEL CENTER
7. NUT, RADIO RECEIVER MOUNTING
8. RECEIVER, RADIO



V2719

Figure 20—Radio Receiver Assembly

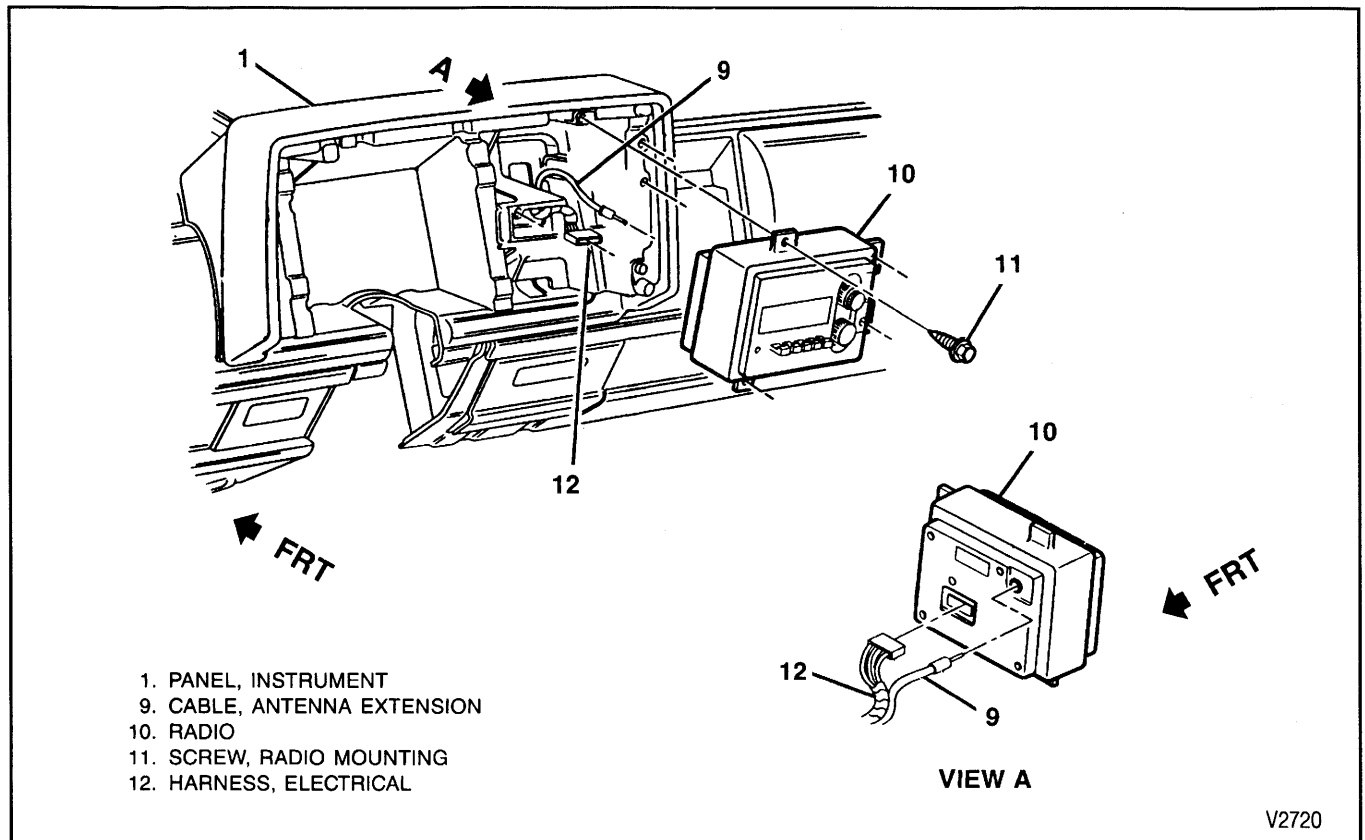


Figure 21—Control Head Assembly (AM—UP4)

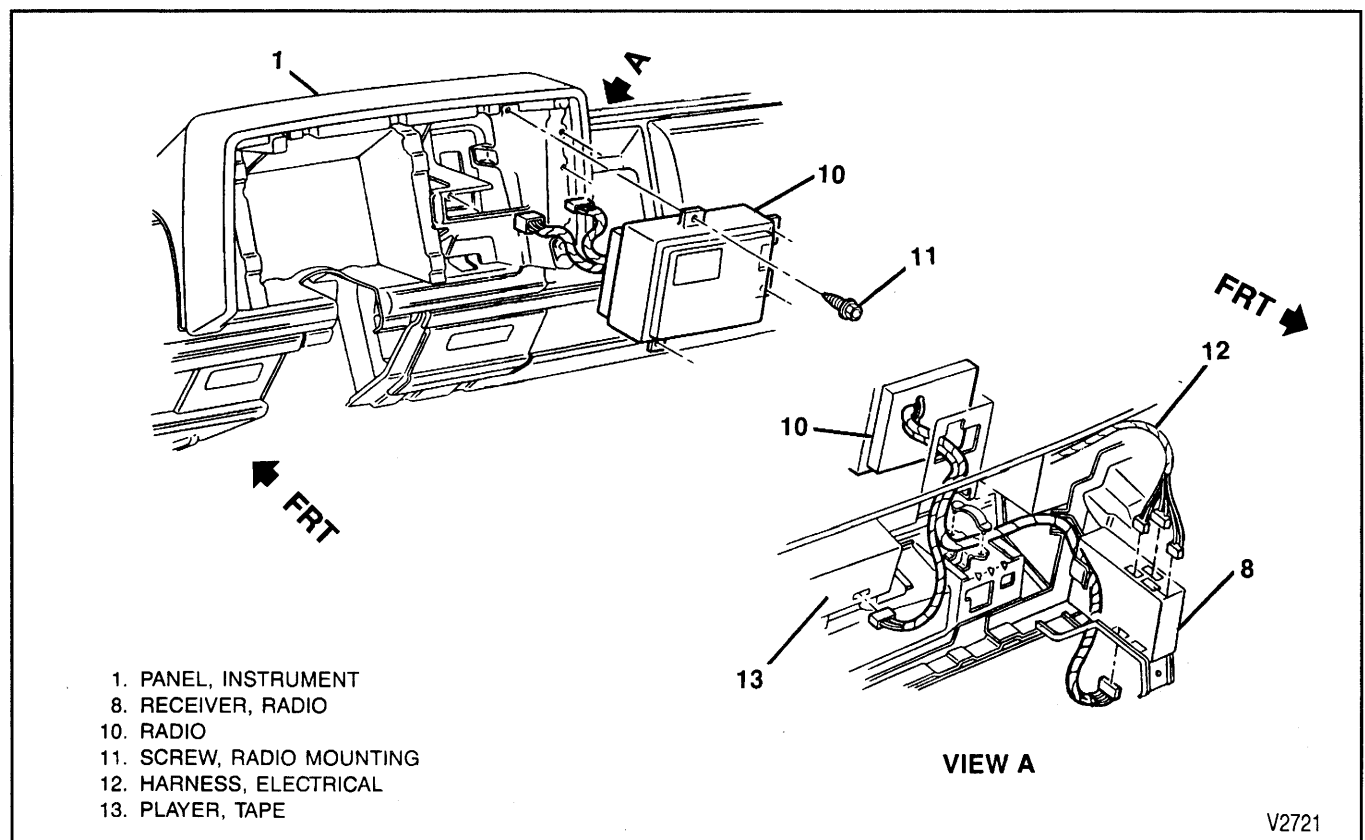
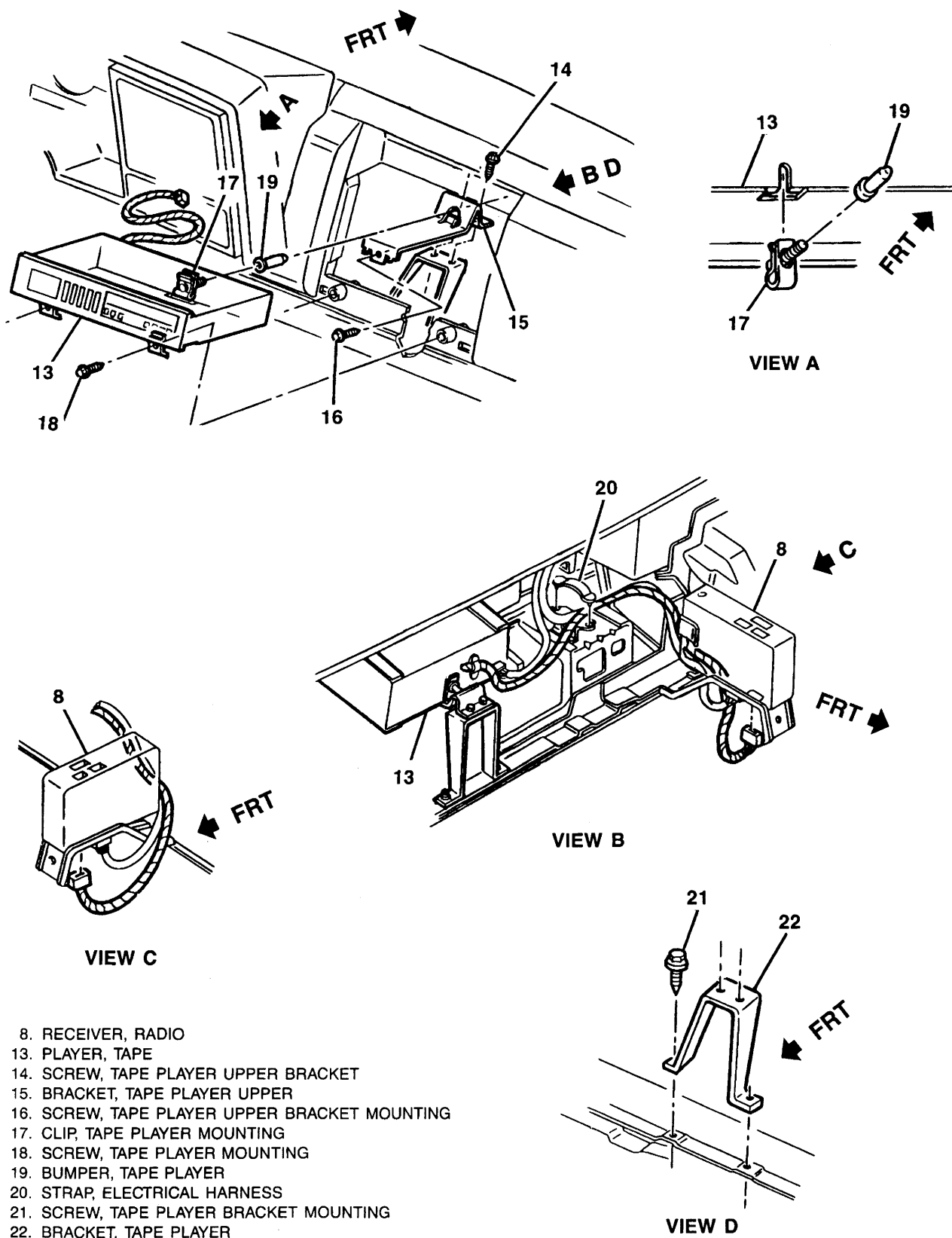


Figure 22—Control Head Assembly (AM/FM—UM6, UM7, UX1)



V2722

Figure 23—Tape Player Assembly

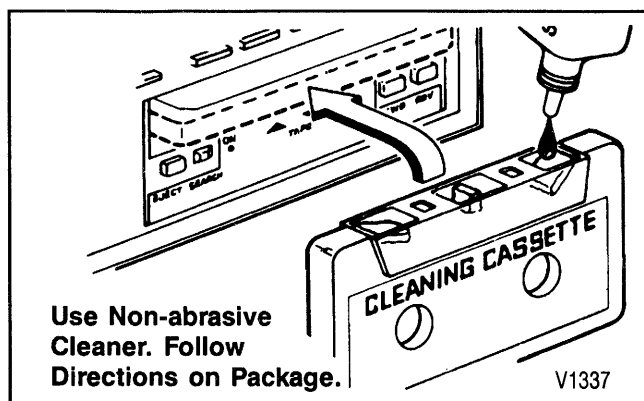


Figure 24—Use of Cleaning Cassette

4. Screws (18).
5. Tape player (13).
6. Bumper (19) and clip (17) from tape player (13).

Install or Connect (Figure 23)

1. Clip (17) and bumper (19) to tape player (13).
2. Tape player (13).
 - Make sure the bumper goes into the hole in the bracket.

NOTICE: Refer to "Notice" on page 9A-1.

3. Screws (18).

Tighten

- Screws (18) to 1.9 N.m (17 lbs. in.).
4. Electrical connectors, as necessary.
 5. Accessory trim plate. Refer to SECTION 10A4.
 6. Negative battery cable.
 - Check circuit operation.

TAPE PLAYER AND CASSETTE CARE

For the best operation of the cassette tape player, do not use cassette tapes that are longer than 90 minutes in playback time (45 minutes per side). Cassette tapes longer than 90 minutes may cause tape slippage or jamming.

Tape Head and Capstan Cleaning

There are two parts that are cleaned on a tape player: the head and the capstan. Since they can be reached through the tape door, leave the tape player in the vehicle. This service should be performed every 50 hours of operation.

To clean the head and capstan, use a cotton swab dipped in ordinary rubbing alcohol, or use a cleaning cassette.

As an alternate way to clean the head and capstan, a cleaning cassette kit may be purchased (figure 24). Follow the instructions included with the kit to clean the tape player.

Do not contact the tape head with magnetized tools. If the head becomes magnetized, every cassette played in the player will be degraded.

No service is performed on the tapes and warranty of these tapes is handled by the cassette manufacturer,

not by the dealer. Any test tape used by the dealer should be stored in its container to keep the tape clean. Store cassettes away from extreme heat or direct sunlight.

AMPLIFIER

Remove or Disconnect (Figures 25 and 26)

1. Negative battery cable. Refer to SECTION 0A.
2. Electrical connectors, as necessary.
3. Amplifier (24) from bracket (25).

Install or Connect (Figures 25 and 26)

1. Amplifier (24) to bracket (25).
2. Electrical connectors, as necessary.
3. Negative battery cable. Refer to SECTION 0A.
 - Check circuit operation.

SPEAKERS

FRONT SPEAKERS

Remove or Disconnect (Figure 27)

1. Speaker grille (28).
2. Screws (29).
3. Speaker (30).
4. Electrical connectors, as necessary.

Install or Connect (Figure 27)

1. Electrical connectors, as necessary.
2. Speaker (30).

NOTICE: Refer to "Notice" on page 9A-1.

3. Screws (29).

Tighten

- Screws (29) to 1.9 N.m (17 lbs. in.).
4. Speaker grille (28).
 - Check circuit operation.

REAR SPEAKERS

Remove or Disconnect (Figures 28 through 32)

1. Speaker grille (36) or rear trim panel (35).
2. Screws (34).
3. Speaker (33).
4. Electrical connectors, as necessary (figures 29, 30, and 32).

Install or Connect (Figures 28 through 32)

1. Electrical connectors, as necessary (figures 29, 30, and 32).
2. Speaker (33).

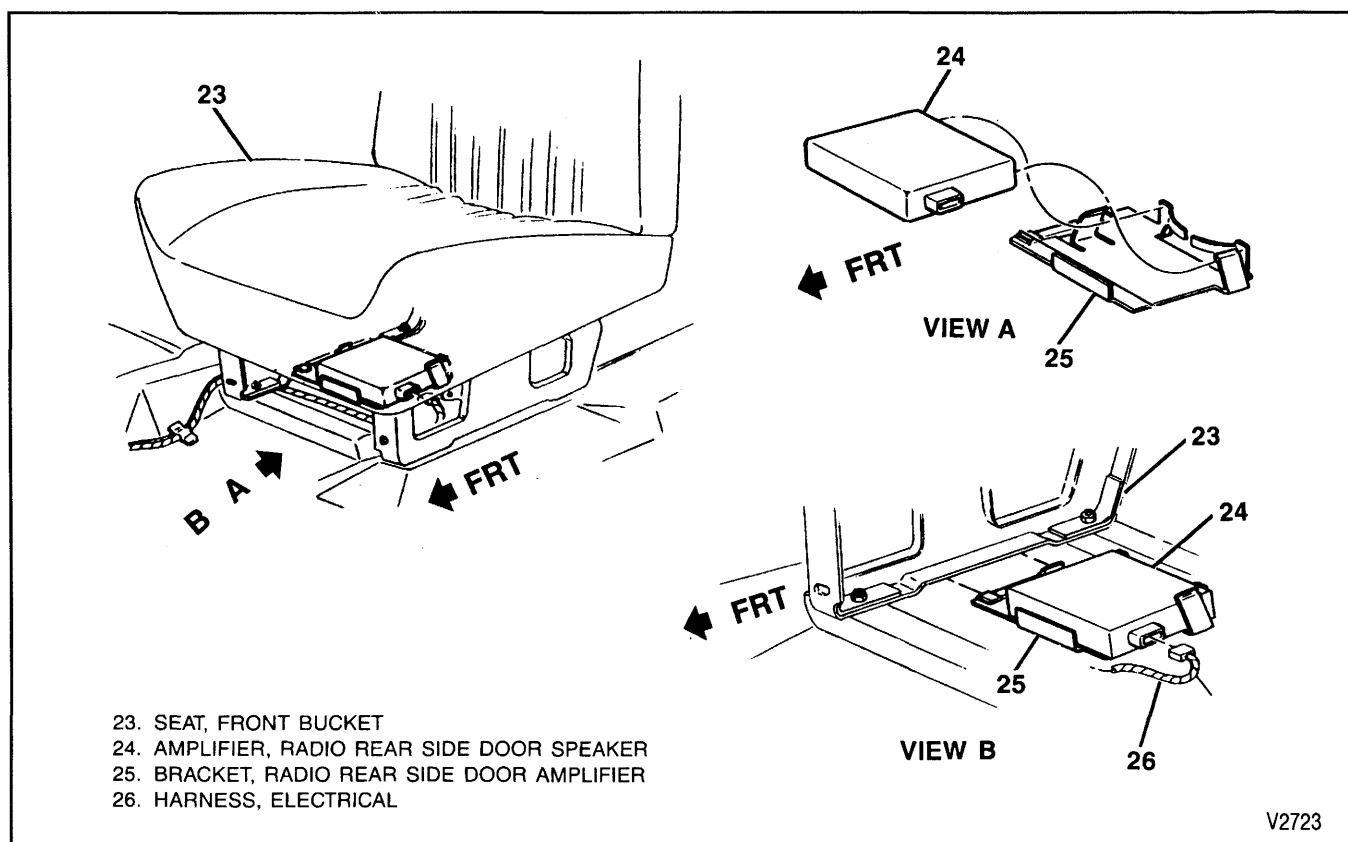


Figure 25—Amplifier Assembly (Front Bucket Seat-Suburban Models)

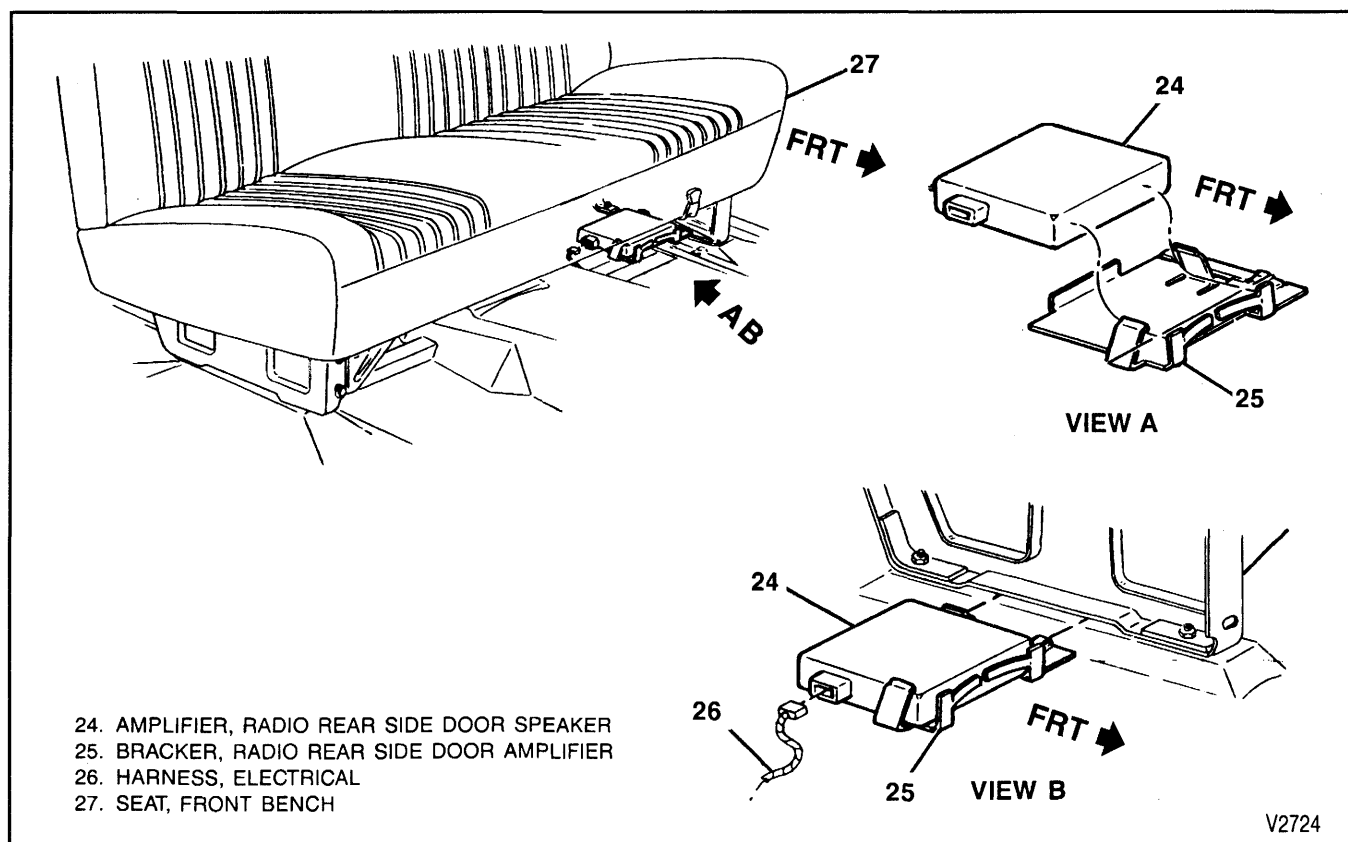


Figure 26—Amplifier Assembly (Front Bench Seat-Suburban Models)

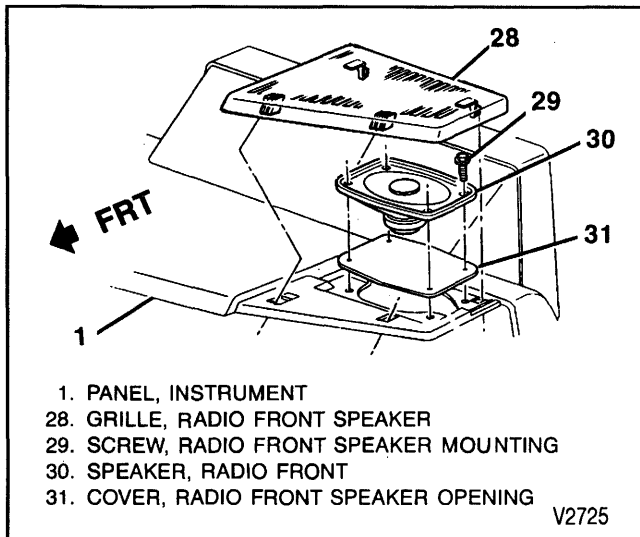


Figure 27—Front Speaker Assembly

NOTICE: Refer to "Notice" on page 9A-1.

3. Screws (34).



Tighten

- Screws (34) to 1.9 N·m (17 lbs. in.).
- 4. Speaker grille (36) or rear trim panel (35).
 - Check circuit operation.

SIDE DOOR SPEAKERS



Remove or Disconnect (Figure 33)

1. Side door map pocket (38). Refer to SECTION 10A1.
2. Electrical connectors, as necessary.
3. Screws (40).
4. Speaker (39) from side door map pocket (38).



Install or Connect (Figure 33)

1. Speaker (39) to side door map pocket (38).

NOTICE: Refer to "Notice" on page 9A-1.

2. Screws (40).



Tighten

- Screws (40) to 1.6 N·m (14 lbs. in.).
- 3. Electrical connectors, as necessary.
- 4. Side door map pocket (38). Refer to SECTION 10A1.
 - Check circuit operation.

REAR OVERHEAD SPEAKERS



Remove or Disconnect (Figure 34)

1. Speaker grille (45).
2. Roof inner trim panel, if necessary. Refer to SECTION 10A4.

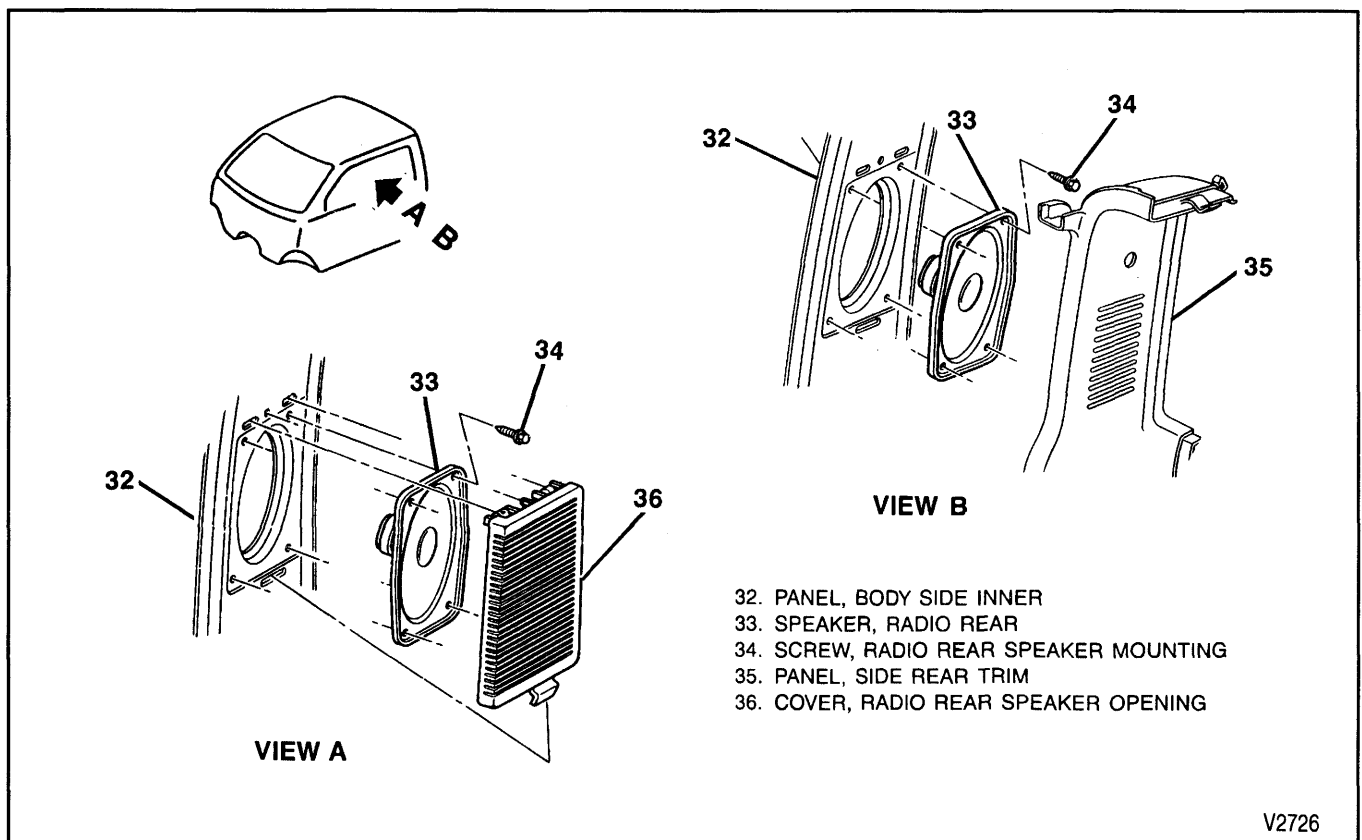


Figure 28—Rear Speaker Assembly (Pickup/Chassis-Cab Models)

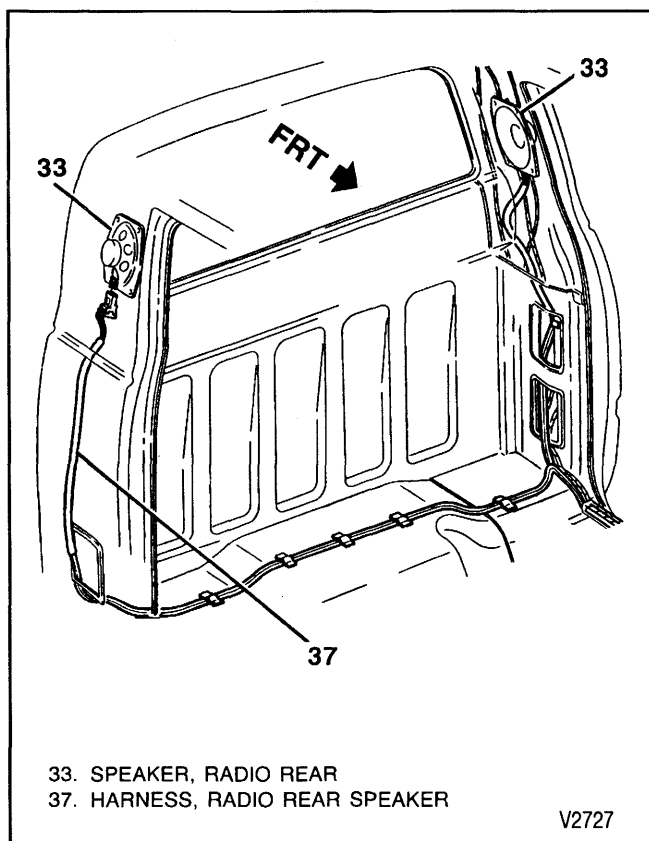


Figure 29—Rear Speaker Harness Routing (Pickup/Chassis-Cab Models)

3. Screws (46).
4. Speaker (43) from bracket (42).
5. Electrical connectors, as necessary.



Install or Connect (Figure 34)

1. Electrical connectors, as necessary.
2. Speaker (43) to bracket (42).

NOTICE: Refer to "Notice" on page 9A-1.

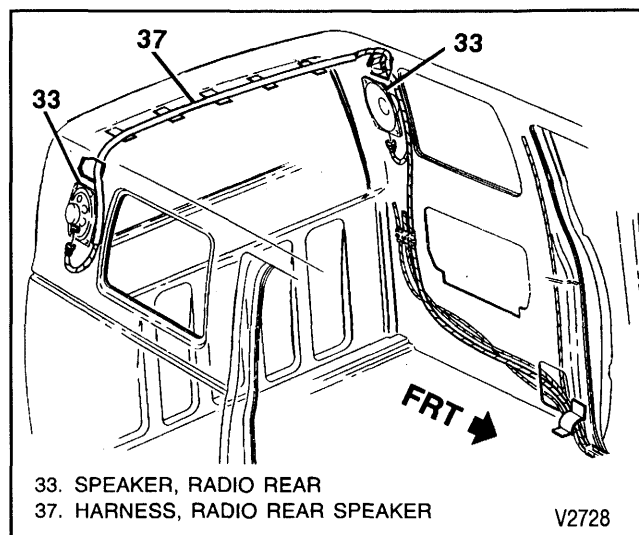


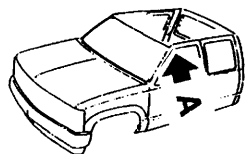
Figure 30—Rear Speaker Harness Routing (Extended Cab Models)

3. Screws (46).

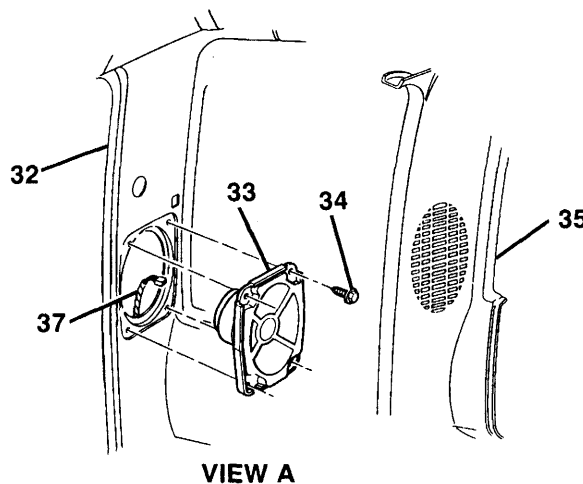


Tighten

- Screws (46) to 1.9 N·m (17 lbs. in.).
4. Roof inner trim panel, if necessary. Refer to SECTION 10A4.
 5. Speaker grille (45).
 - Check circuit operation.



32. PANEL, BODY SIDE INNER
33. SPEAKER, RADIO REAR
34. SCREW, RADIO REAR SPEAKER MOUNTING
35. PANEL, SIDE REAR TRIM
37. HARNESS, RADIO REAR SPEAKER



V2729

Figure 31—Rear Speaker Assembly (Extended Cab/Crew Cab Models)

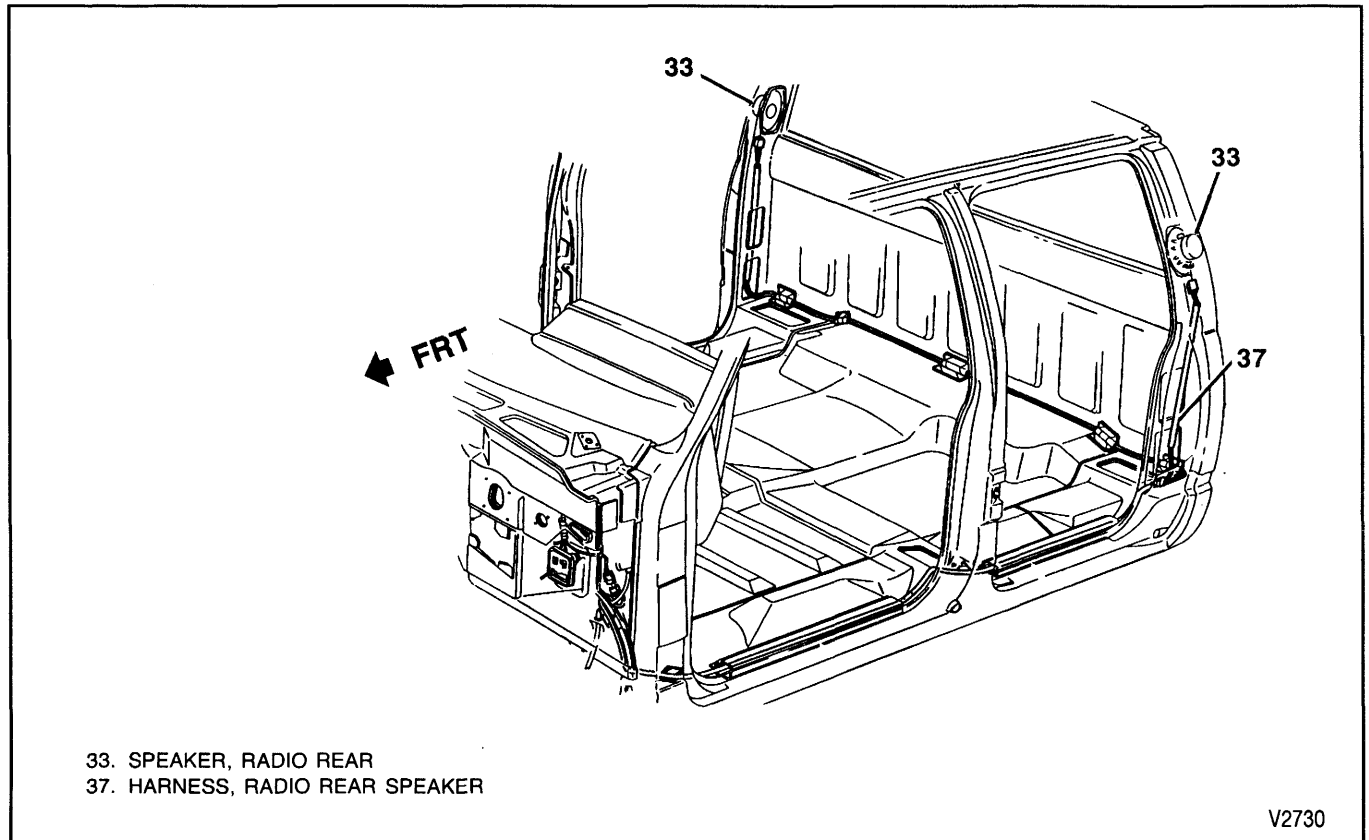


Figure 32—Rear Speaker Harness Routing (Crew Cab Models)

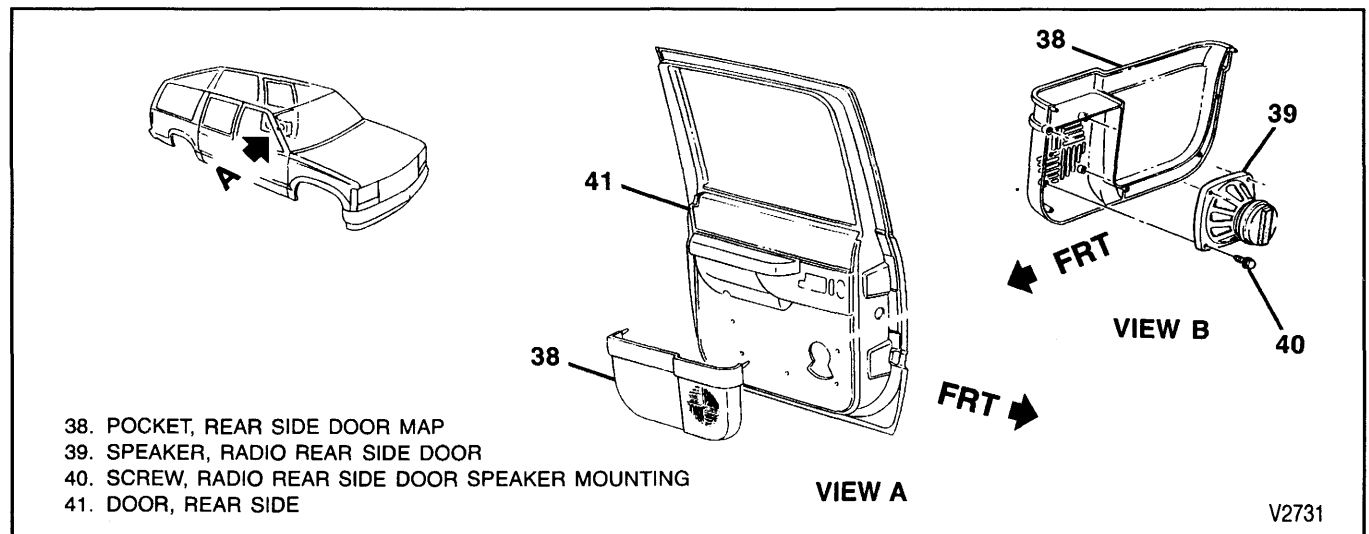


Figure 33—Rear Side Door Speaker Assembly (Suburban Models)

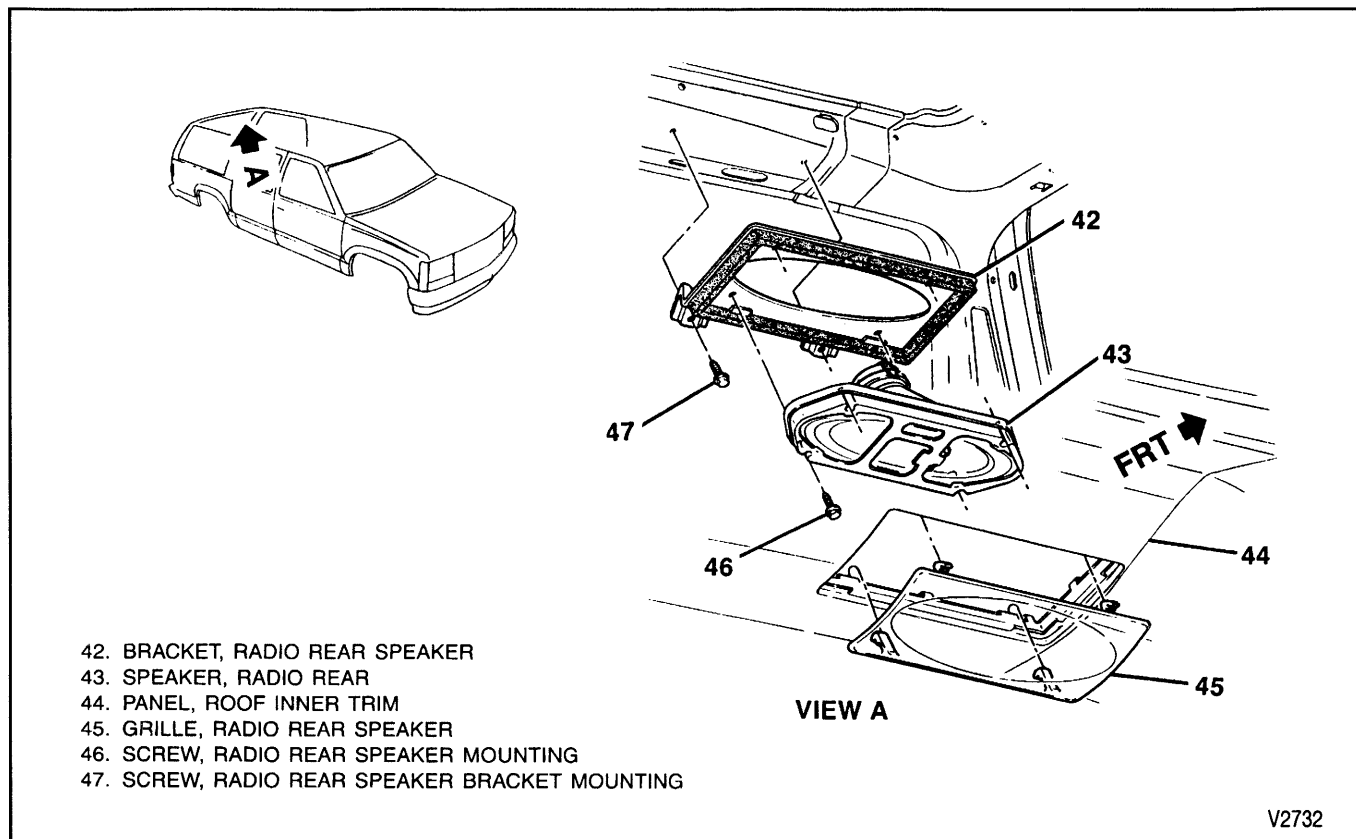


Figure 34—Rear Overhead Speaker Assembly (Suburban and Utility Models)

ANTENNAS

GENERAL DESCRIPTION

The fixed mast barbless antenna is designed to withstand most car washes without damage. It cannot be adjusted up or down. If the mast becomes slightly bent, straighten it by hand. The antenna can be replaced if it becomes severely bent. Antennas must be kept clean for good performance.



Important

- When using a replacement radio, inspect the antenna connector(s) for the proper type. If necessary, use one of the following adapters.
 - Barbed-to-Barbless Antenna Adapter (GM P/N 16169611)
 - Barbless-to-Barbed Antenna Adapter (GM P/N 16169591)

DIAGNOSIS

Disconnect antenna from the extension cable and plug in a test antenna. Make sure the test antenna is grounded to the vehicle chassis and keep hands off of the antenna. Check radio reception in an area away from electrical interferences such as tall buildings, metal structures, power lines, fluorescent lighting, and power tools. Tune to high and low ends of the dial on both AM and FM, checking weak and strong station reception. If reception is okay, the problem exists with the antenna and/or its lead-in cable. If reception is still poor, refer to "Diagnostic Charts" earlier in this section.

Testing for Good Ground of Antenna Mounting and Connections

Poor grounding at the antenna mounting or any connection in the antenna/lead-in system can result in seri-

ously reduced radio performance. A poor ground can be a reason for excess ignition noise on AM or erratic audio. Also, be sure lead-in connectors are free of dirt and corrosion, and are tightly fastened.

Possible ground loss or high-resistance ground points are:

- Antenna upper mounting (loose screws, paint overspray, etc.).
- Lead-in cable connector at antenna (loose or internally corroded).
- Lead-in cable connector at radio (loose or internally corroded).
- Quick connect connector (corroded).
- Missing ground lead.

Checking Lead-In Cable

Usually, a broken center conductor of the lead-in cable will result in no AM and weak FM. In case of continued reception or noise complaints, always check the lead-in with an ohmmeter (figure 35).

When checking resistance, wiggle the lead-in tip and cable. If the readings shown in figure 35 are not obtained, some portion of the lead-in is intermittent and the lead-in should be replaced.

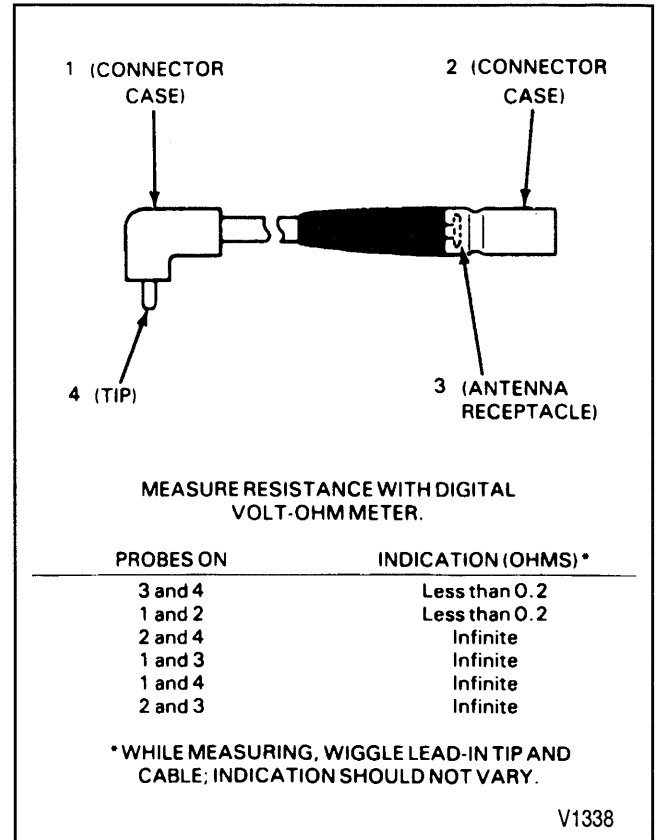


Figure 35—Lead-In Cable Diagnosis

ON-VEHICLE SERVICE

FIXED ANTENNA

↔ Remove or Disconnect (Figures 36 and 37)

1. Antenna mast (44).
2. Nut (47).
3. Bezel (45).
4. Antenna cable (43) from extension cable (9).

5. Screws (46).
6. Antenna cable assembly (43).

↔ Install or Connect (Figures 36 and 37)

1. Antenna cable assembly (43).

NOTICE: For steps 2 and 5, refer to "Notice" on page 9A-1.

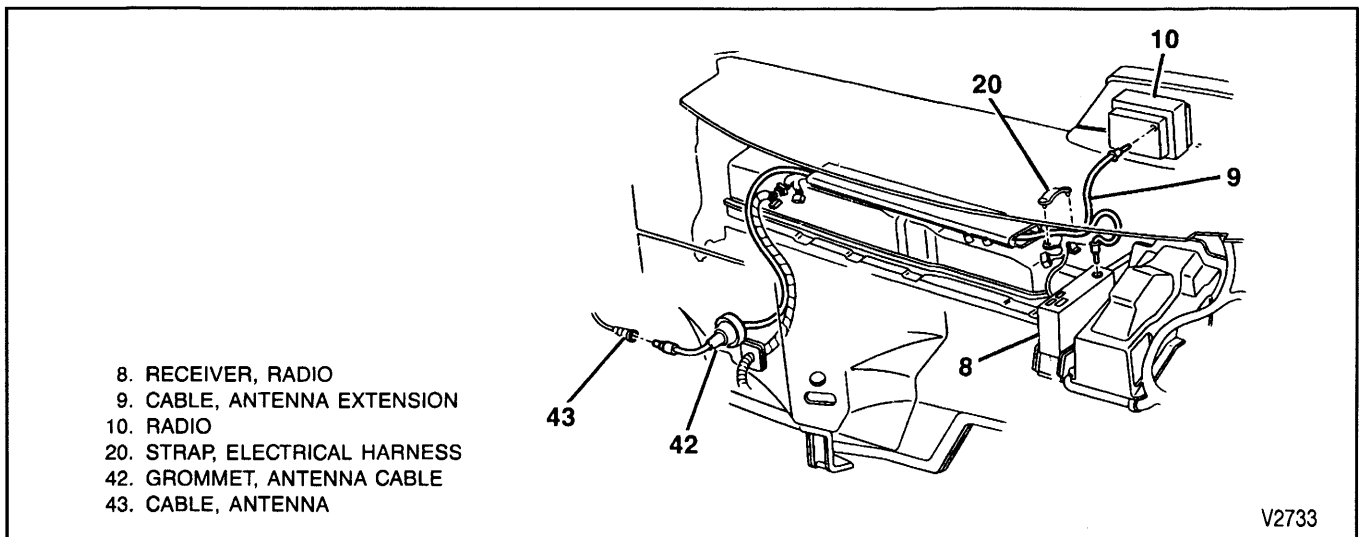


Figure 36—Antenna Extension Cable Routing

9A-34 AUDIO SYSTEMS

2. Screws (46).



Tighten

- Screws (46) to 5 N.m (58 lbs. in.).

3. Antenna cable (43) to extension cable (9).

4. Bezel (45).

5. Nut (47).



Tighten

- Nut (47) to 5 N.m (58 lbs. in.).

6. Antenna mast (44).

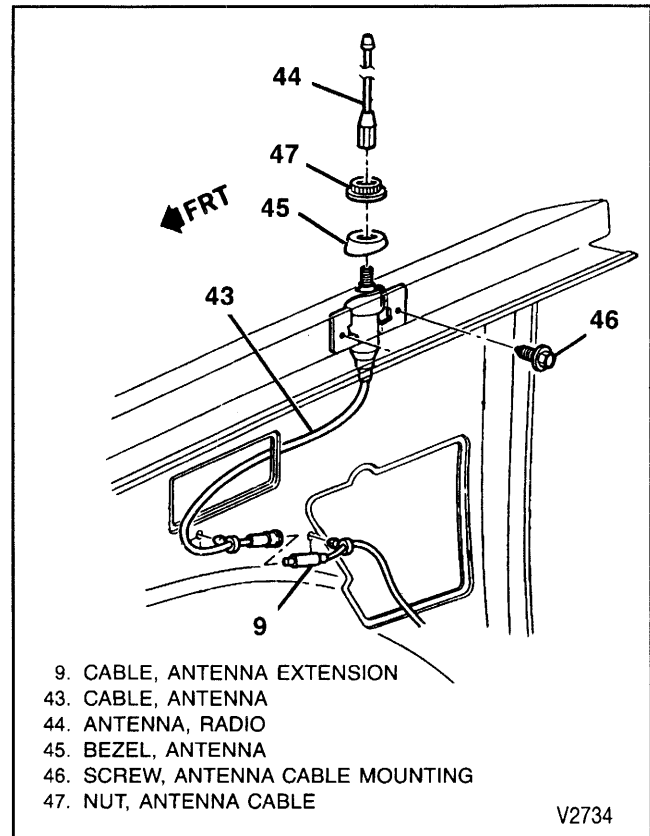


Figure 37—Antenna Cable Assembly

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Antenna Cable Mounting Screw	5 N·m (58 lbs. in.)
Antenna Mounting Nut	5 N·m (58 lbs. in.)
Control Head Mounting Screw	1.9 N·m (17 lbs. in.)
Front Speaker Mounting Screw	1.9 N·m (17 lbs. in.)
Radio Receiver Bracket-to-Instrument Panel Screw	1.9 N·m (17 lbs. in.)
Radio Receiver-to-Mounting Bracket Nut	2.5 N·m (22 lbs. in.)
Rear Overhead Speaker Mounting Screw	1.9 N·m (17 lbs. in.)
Rear Speaker Mounting Screw	1.9 N·m (17 lbs. in.)
Side Door Speaker Mounting Screw (Suburban)	1.6 N·m (14 lbs. in.)
Tape Player Mounting Screw	1.9 N·m (17 lbs. in.)

T2848

SECTION 9B

CRUISE CONTROL

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

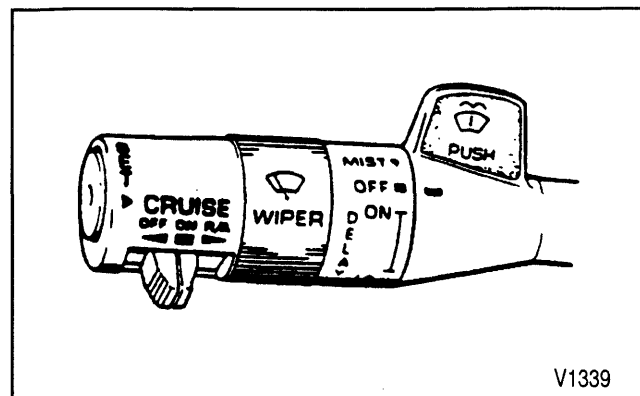
The AC Electro-Motor Cruise System is a speed control system that maintains a desired vehicle speed under normal driving conditions. The system also has the capability to CRUISE, COAST, RESUME SPEED, ACCELERATE, TAP-UP, and TAP-DOWN.

The main components of this system are the functional control switches, cruise control module, vehicle speed sensor, vehicle speed sensor buffer, electrical release switches, and electrical harness.

The cruise control module contains an electronic controller and an electric stepper motor. The controller monitors vehicle speed and operates the electric stepper motor. The motor moves a band and throttle linkage, in response to the controller, to maintain the desired cruise speed.

The cruise control module contains a low speed limit which will prevent system engagement below a minimum speed, about 40 km/h (25 mph). The controller operates in response to the functional control switches located on the turn signal lever (figure 1).

Release switches disengage the cruise system. They are mounted either on the brake pedal bracket (automatic transmission models), or the clutch pedal bracket (manual transmission models). When the brake or



V1339

Figure 1—Turn Signal Lever

9B-2 CRUISE CONTROL

clutch pedal is depressed, the cruise system is electrically disengaged and the throttle is returned to the idle position.

NOTICE: *To keep the vehicle under control, and to prevent possible vehicle damage, it is not advisable to use the cruise control on slippery roads. Using the cruise control in conditions such as on winding roads or in traffic or varying volume is not recommended. When traveling down a steeply graded hill, the cruise control should be disengaged by pressing the brake or clutch pedal lightly. The transmission can then be shifted to a lower gear range to help control vehicle speed.*

CRUISE CONTROL MODULE

The cruise control module assembly is mounted on the cowl. The assembly has an electronic controller and an electric stepper motor to vary the throttle with each different cruise control mode. The module assembly is not serviceable.

BRAKE RELEASE SWITCHES

These switches are used to disengage the cruise control system. A TCC/cruise control switch and a stoplamp switch mounted on the brake or clutch pedal mounting bracket disengage the system electrically when the brake or clutch pedal is depressed. This is done by interrupting the flow of the current to the module. The speed of the vehicle at brake actuation will be stored in the memory of the system. The cruise function remains disengaged after the brake or clutch pedal is released.

For replacement procedures, refer to SECTION 5.

VEHICLE SPEED SENSOR

The vehicle speed sensor (VSS) is mounted to the automatic/manual transmission assembly and produces an AC signal. The frequency of this signal is proportional to the speed at which the automatic/manual transmission output shaft rotates, which in turn, is proportional to the speed of the vehicle.

The AC signal produced by the VSS is amplified and converted by the VSS buffer assembly. The signal is supplied to the ECM/PCM, cruise control module, and speedometer assembly by the VSS buffer. The VSS buffer assembly produces the signal by opening and closing internal solid state switches to ground.

The signal to the ECM/PCM, cruise control module, and speedometer pulses at a rate of 4,000 times per mile. The ECM/PCM, cruise control module, and speedometer internally convert the number of pulses per mile per second to determine vehicle speed.

For replacement procedure, refer to SECTION 7A14A, 7A17A, or 7B.

VEHICLE SPEED SENSOR BUFFER

The vehicle speed sensor (VSS) buffer receives a signal from the VSS (permanent magnet generator) indicating the speed of the vehicle. This signal is then

processed by the VSS buffer assembly and supplied to the ECM/PCM, cruise control module, and the speedometer assembly.

For replacement procedures, refer to SECTION 8C.

FUNCTION CONTROL SWITCHES

ON/OFF

The "ON" and "OFF" position slide switch, located on the multifunction lever assembly, controls electrical power to the cruise control system. When the switch is in the "OFF" position the system cannot be engaged. When the switch is in the "ON" position the system may be engaged by either the "SET" or "RESUME" switch at any speed above approximately 40 km/h (25 mph).

SET/COAST Button Switch

The cruise control "SET/COAST" switch controls three functions.

- **The Set Function**--When the "SET/COAST" switch is depressed and then released, with vehicle speed above the low speed limit point, and the "ON/OFF" switch in the "ON" position, the cruise speed will be set at the particular speed the vehicle was at when the button was released. Cruise speed will be within ± 1.6 km/h (1 mph) of the actual speed when engaged. The system will cruise until either the "ON/OFF" switch is moved to "OFF," the ignition switch is turned off, and/or the "SET/COAST" button is pushed in fully and held. Pushing the brake or clutch pedal disengages the system, but the set speed is maintained in memory allowing a "RESUME" at a later time.
- **The Coast (Trim) Function**--When the "SET/COAST" button switch is fully depressed, the driver can raise or lower his control speed. To increase control speed, the driver would accelerate to a new speed, fully depress the switch, so the ECM/PCM releases previously set speed, and release the button. Upon releasing the button, a new speed is set. An increased control speed can also be more easily set by the "RESUME/ACCEL" switch as described later. To decrease cruise speed, the "SET/COAST" switch is held in the depressed position, disengaging the cruise system, allowing the throttle to return to the idle position. When the vehicle has slowed to the desired lower cruise speed, releasing the switch will cause the system to cruise at the new speed.
- **The "Tap Down" Function**--For this function to operate, the cruise must be engaged and operating. "Tapping down" is done by quickly pressing the "SET/COAST" button to the depressed position and quickly releasing it, or "tapping" the button. Do not hold the button in the depressed position or the system will revert to the "coast" mode. "Tap down" is a function in which cruise speed can be decreased by 1.6 km/h (1 mph) increments (one tap = 1 mph decrease). The system can "tap down" to a limited speed of 40 km/h (25 mph). Below this speed, cruise control will not operate.

The accelerator may be depressed at any time to override the cruise system. Release of the accelerator will return the vehicle to the previous set cruise speed

RESUME/ACCEL Switch

The "RESUME/ACCEL" switch controls three functions.

- **The Resume Function**--If the cruise system has been disengaged by depressing the brake or clutch pedal, it may be reactivated by momentarily holding the "RESUME/ACCEL" switch. This will cause the vehicle to accelerate to the previously set speed and cruise at that speed. The resume function will not work if the cruise "ON/OFF" switch or the ignition switch has been cycled since the last time cruise was active or the vehicle speed is below the low speed lockout 40 km/h (25 mph).

- **The Accelerate Function**--By sliding the "RESUME/ACCEL" switch and holding it, the vehicle will accelerate until the switch is released. The cruise "ON/OFF" switch must be on and the vehicle speed must be above the low speed lockout 40 km/h (25 mph) for this function to operate.
- **The "Tap Up" Function**--For this function to operate, the cruise must be engaged and operating. "Tapping up" is done by quickly pressing the slide switch toward the "R/A" position and quickly releasing it, or "tapping" the lever. Do not hold the lever in the "R/A" position or the system will revert to the "Accel" mode. "Tap up" is a function in which cruise speed can be increased by 1.6 km/h (1 mph) increments (one tap=1 mph increase). The system cannot "tap up" beyond 210 km/h (125 mph).

DIAGNOSIS

Malfunctions can be either mechanical or electrical. In resolving any cruise system problem, first complete the following initial inspection.

PRELIMINARY INSPECTION

- Check "GAGES" 20 amp fuse.
- Check for bare, broken, or disconnected wires.
- Check for dirty, corroded, or loose ground terminals.
- Check for binding or sticking linkage at the throttle body.
- Check for damaged or mispositioned brake and/or clutch switches.

CRUISE SYSTEM FUNCTIONAL CHECK

The procedure below is used to check the operating modes of the cruise control system. This procedure should always be used after repair work has been completed on the cruise system. Steps 1-7 and 10 are used with automatic and manual transmission models, while steps 8 and 9 are for manual transmission models only.

1. Slide the turn signal lever cruise switch to the "ON" position.
2. **Check the Low Speed Inhibit:** Drive the vehicle at 32 km/h (20 mph). Depress "SET" push button and release. Cruise control must not engage.
3. **Check Set Speed:** Drive vehicle at steady speed of 89 km/h (55 mph). Depress "SET" push button completely and release. Cruise control should engage at approximately 89 km/h (55 mph).

4. **Check Brake Release:** Depress brake pedal. The cruise control must release throttle, allowing the vehicle speed to drop. The system must not re-engage when the brake is released.
5. **Check Resume Feature:** With the vehicle speed at approximately 72 km/h (45 mph), slide the cruise switch momentarily (less than 1 second) to the "R/A" position. The vehicle should accelerate to approximately 89 km/h (55 mph).
6. **Check Coast Feature:** Depress the "SET" push button and hold. Allow the vehicle speed to drop to 80 km/h (50 mph) and release push button. Cruise control should hold vehicle speed at approximately 80 km/h (50 mph).
7. **Check Accelerate Feature:** Slide the cruise switch to the "R/A" position and hold. The vehicle speed should begin to increase. Allow the speed to increase to 89 km/h (55 mph) and release switch. The cruise control should hold the vehicle at approximately 89 km/h (55 mph).
8. **Check Clutch Release:** Depress clutch pedal. The cruise control must release throttle, allowing the vehicle speed to drop. The system must not re-engage when the clutch pedal is released.
9. Slide the turn signal lever cruise switch to the "R/A" position momentarily to resume 89 km/h (55 mph).
10. **Check Off Switch:** Turn the turn signal lever cruise switch to the "OFF" position. This must disengage the cruise control system.

If preliminary inspection reveals no solution, refer to the "Driveability, Emissions, and Electrical Diagnosis Manual" for these models.

ON-VEHICLE SERVICE

CRUISE CONTROL CABLE

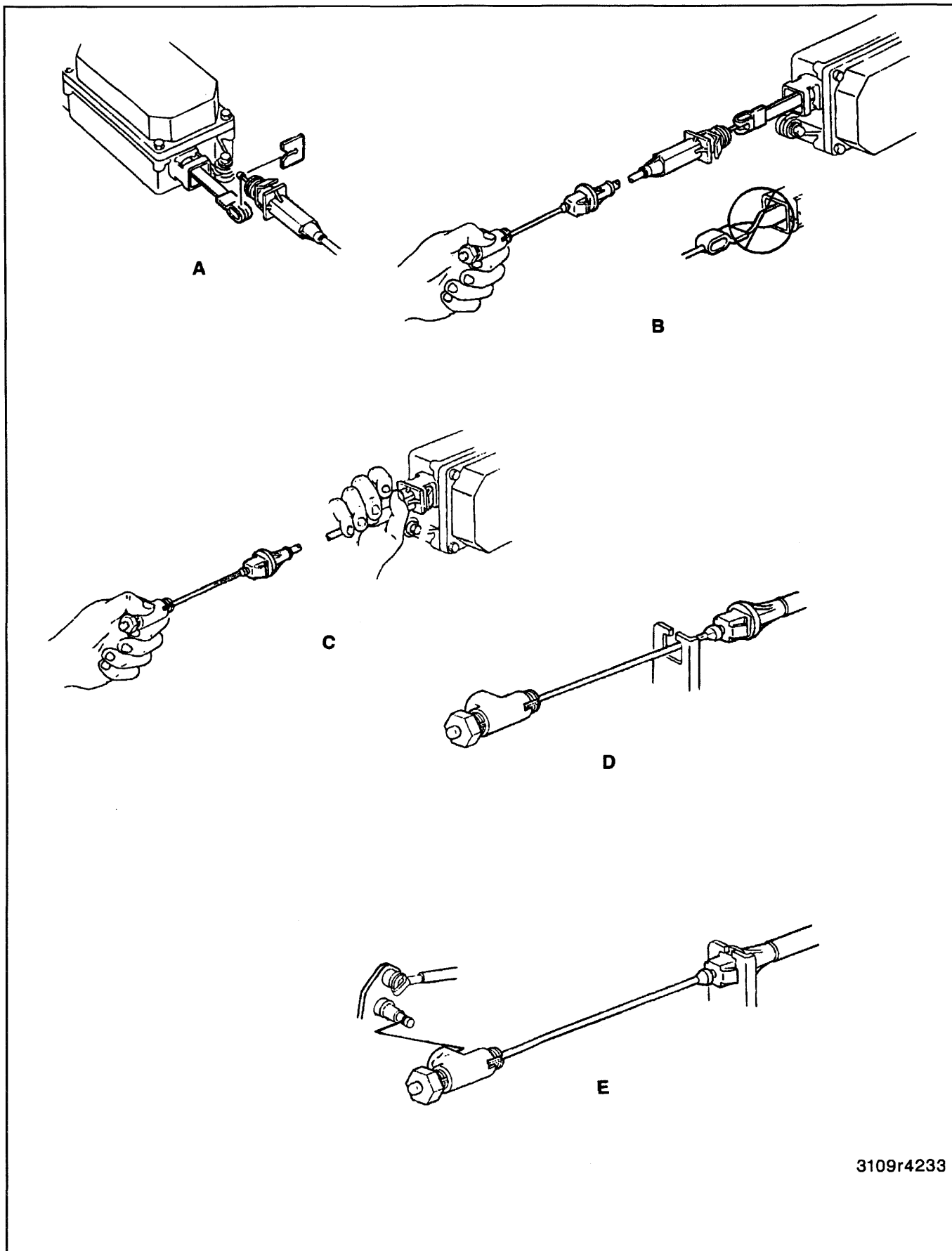


Remove or Disconnect (Figures 2 and 3)

1. Cable end fitting from cable stud.

2. Cable conduit from the cable bracket.
3. Cable conduit from the module housing.
4. Cable bead from the end of the ribbon.

9B-4 CRUISE CONTROL



3109r4233

Figure 2—Cruise Control Cable

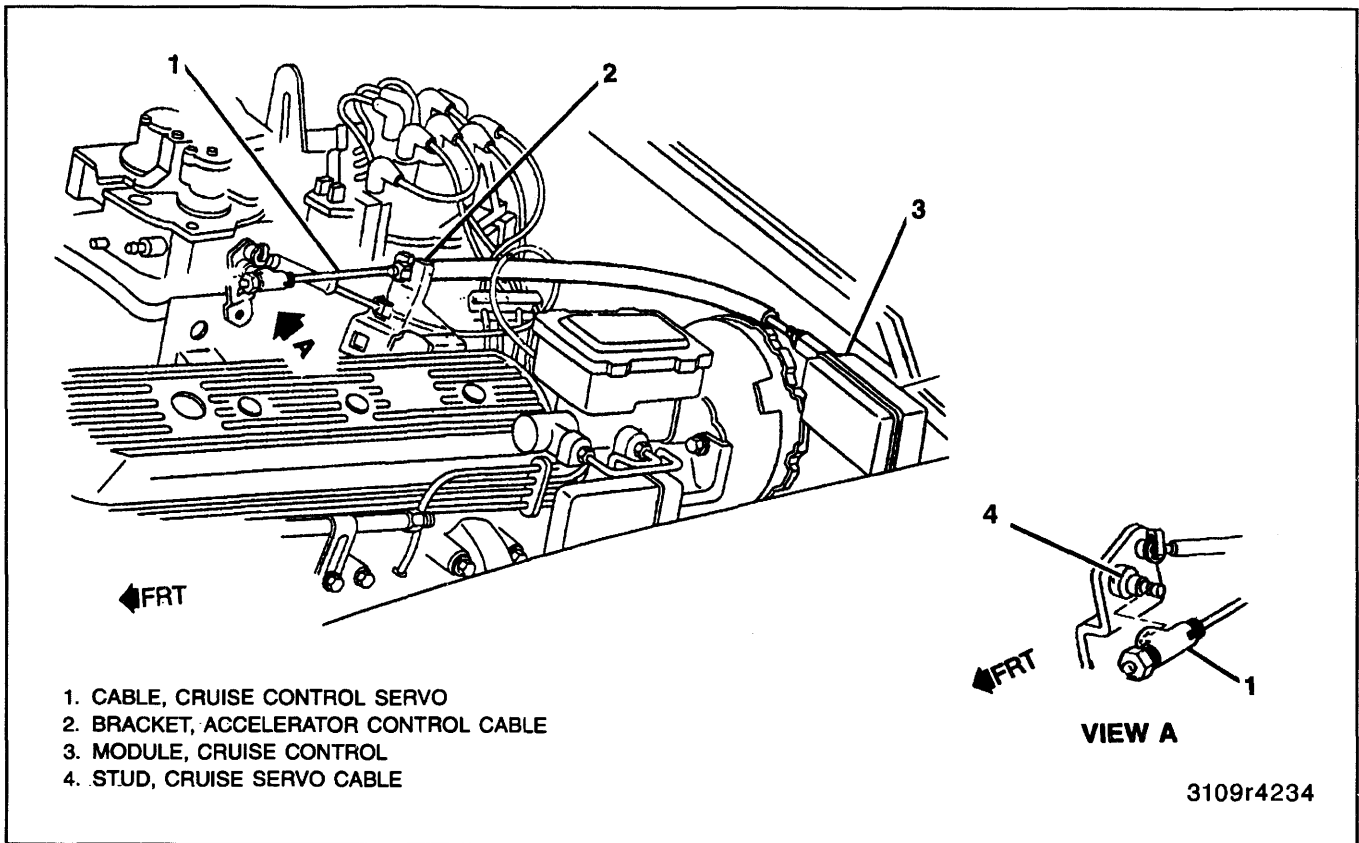


Figure 3—Cruise Control Cable Routing

Install or Connect (Figures 2 and 3)

1. Attach cable end to cruise motor ribbon end fitting. (Refer to A in figure 2.)
2. Pull cruise cable engine end fitting until cable is taut. (Refer to B in figure 2.)
3. Turn cruise cable engine end fitting to straighten ribbon. Ribbon must be flat and horizontal. (Refer to B in figure 2.)
4. Slide cable conduit over ribbon and install tangs in cruise motor housing. (Refer to C in figure 2.)
5. Install cable conduit in engine bracket. Press firmly until the tangs lock. (Refer to D in figure 2.)
6. Install cable end fitting to TBI lever stud. (Refer to E in figure 2.)
7. Check for 0.0 to 5.0-mm (0.197-inch) clearance, or lash, in cruise cable. Turn adjuster screw, if required.

MODULE

Remove or Disconnect (Figure 4)

1. Negative battery cable. Refer to SECTION 0A.
2. Cruise control cable. Refer to "Cruise Control Cable."
3. Electrical connector(s), as necessary.
4. Mounting screws.
5. Module.

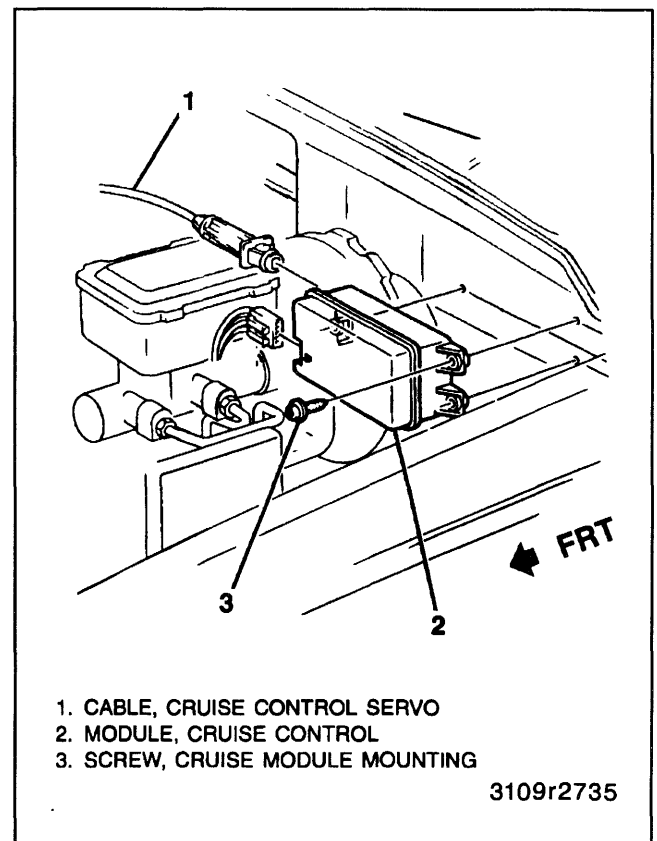


Figure 4—Cruise Control Module

9B-6 CRUISE CONTROL



Install or Connect (Figure 4)

1. Module.

NOTICE: Refer to "Notice" on page 9B-1.

2. Mounting screws.



Tighten

- Screws to 4.5 N·m (40 lbs. in.).

3. Electrical connector(s), as necessary.

4. Cruise control cable. Refer to "Cruise Control Cable."

5. Negative battery cable.

- Check circuit operation.

ENGAGEMENT SWITCH

The cruise control engagement switch is part of the multifunction lever assembly and is not serviceable by itself. The multifunction lever and switch must be replaced as an assembly. For replacement procedures, refer to SECTION 3F.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Cruise Control Module Mounting Screw.....	4.5 N·m (40 lbs. in.)
	T2847

SECTION 9E

ENGINE COOLANT HEATER

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The optional engine coolant heater (RPO K05) is used to preheat engine coolant for cold weather starting. The engine coolant heater operates from a 110-volt AC power source and uses a heating element which is installed in the water jacket of the engine block. The

heating element warms the coolant as long as the heater cord is plugged into the AC power source.

The unit has a detachable electrical cord. If the heater fails to operate, check the cord, connections, and power supply before replacing the heating element.

ON-VEHICLE SERVICE

ENGINE COOLANT HEATER

**Remove or Disconnect (Figures 1 through 5)**

1. Engine coolant. Refer to SECTION 6B1.
2. Coolant jacket plug.
 - If not originally equipped with an engine coolant heater, remove the coolant jacket plug. Carefully tap it near its outer edge, causing it to rotate out of the hole. Do not score the machined surface of the hole. Grasp with pliers and pull to remove.
3. Cord from engine coolant heater.
4. Loosen bolt.
5. Engine coolant heater.

**Clean**

- Core plug hole, removing any burrs, compound, paint, or rough spots.

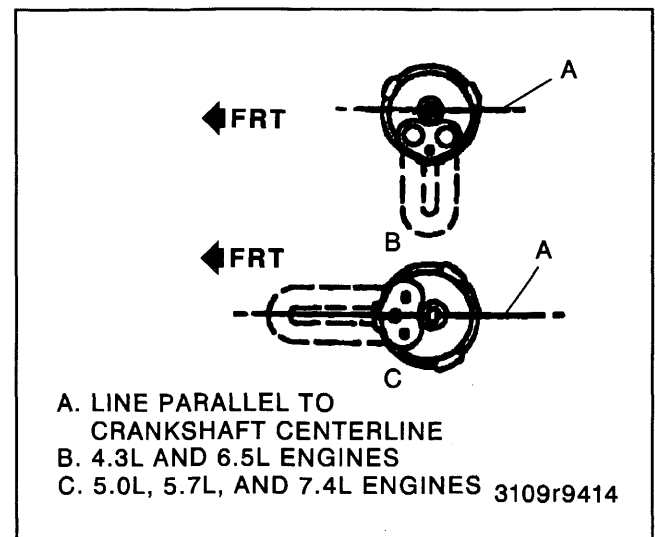


Figure 1—Engine Coolant Heater

9E-2 ENGINE COOLANT HEATER

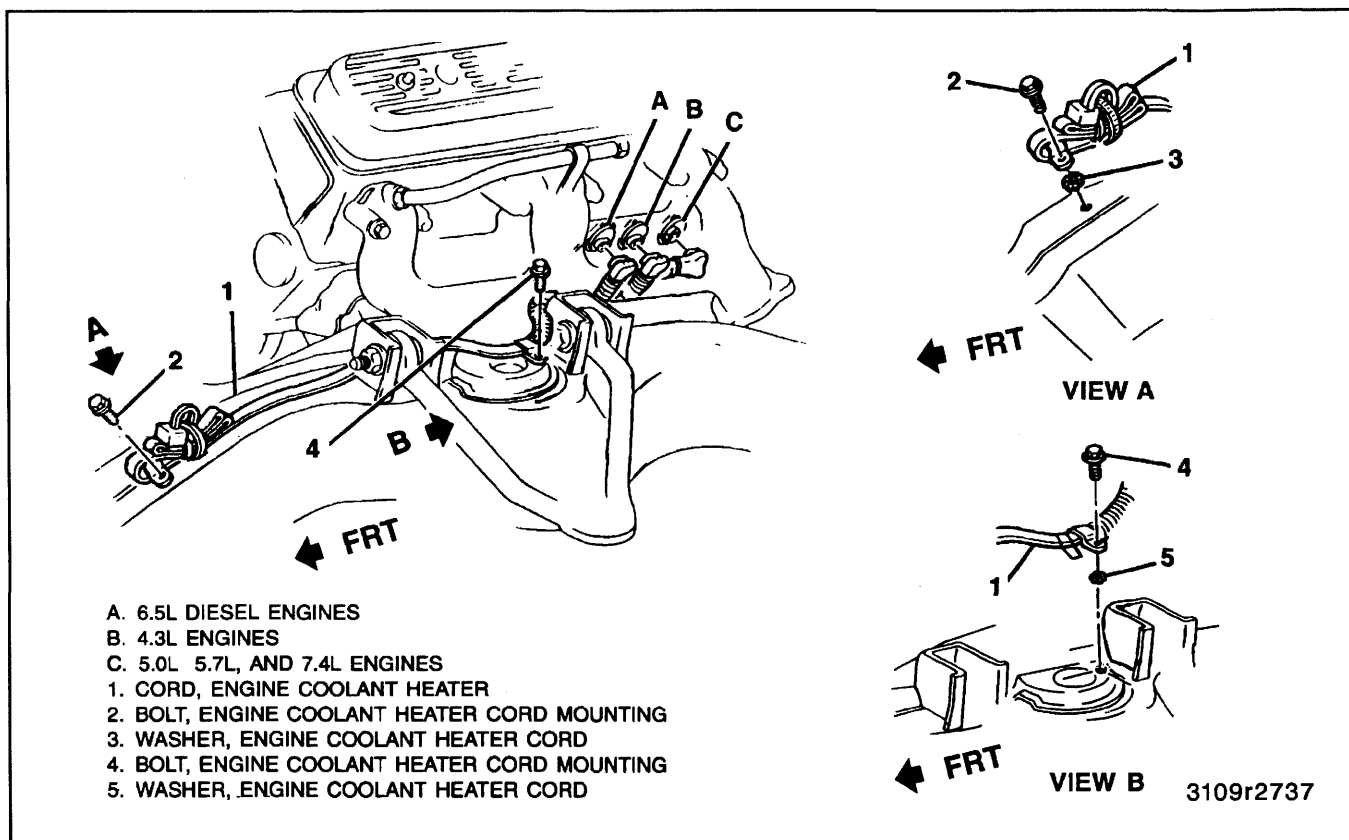


Figure 2—Engine Coolant Heater Cord Routing (Two-Wheel Drive Models)

Install or Connect (Figures 1 through 5)

1. Apply a coating of lubricant to the O-ring seal and the cleaned surface of plug opening in the block. Use a water spray resistant, high-temperature grease (GM P/N 9985164) or equivalent.
2. The coolant heater and push tight to the block.

Important

- Install the heater element in the correct direction to avoid element contact to the inside walls of the engine block as shown in figures 1 and 2.

NOTICE: Refer to "Notice" on page 9E-1.

3. Tighten screw until both locking wings draw tight against inner wall of engine block.

Tighten

- Screw to 1.8 N.m (16 lbs. in.).

4. Heater cord to the coolant heater and route heater cord (figures 3 through 6).

Important

- The heater cord must not touch the engine, hot pipes, manifold, or any moving parts.
5. Engine coolant. Refer to SECTION 6B1.
- Check the system for leaks.

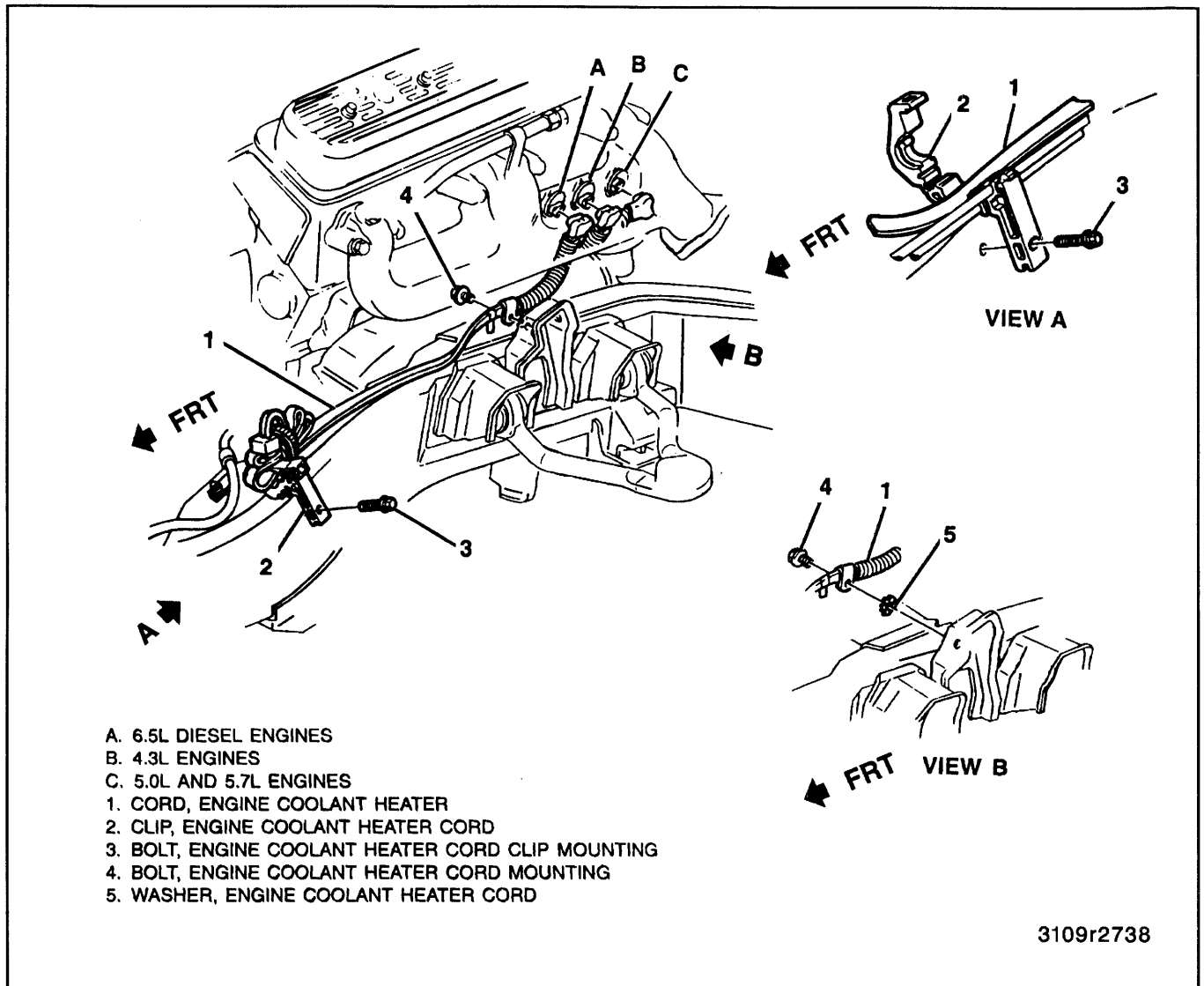


Figure 3—Engine Coolant Heater Cord Routing (Four-Wheel Drive Models)

9E-4 ENGINE COOLANT HEATER

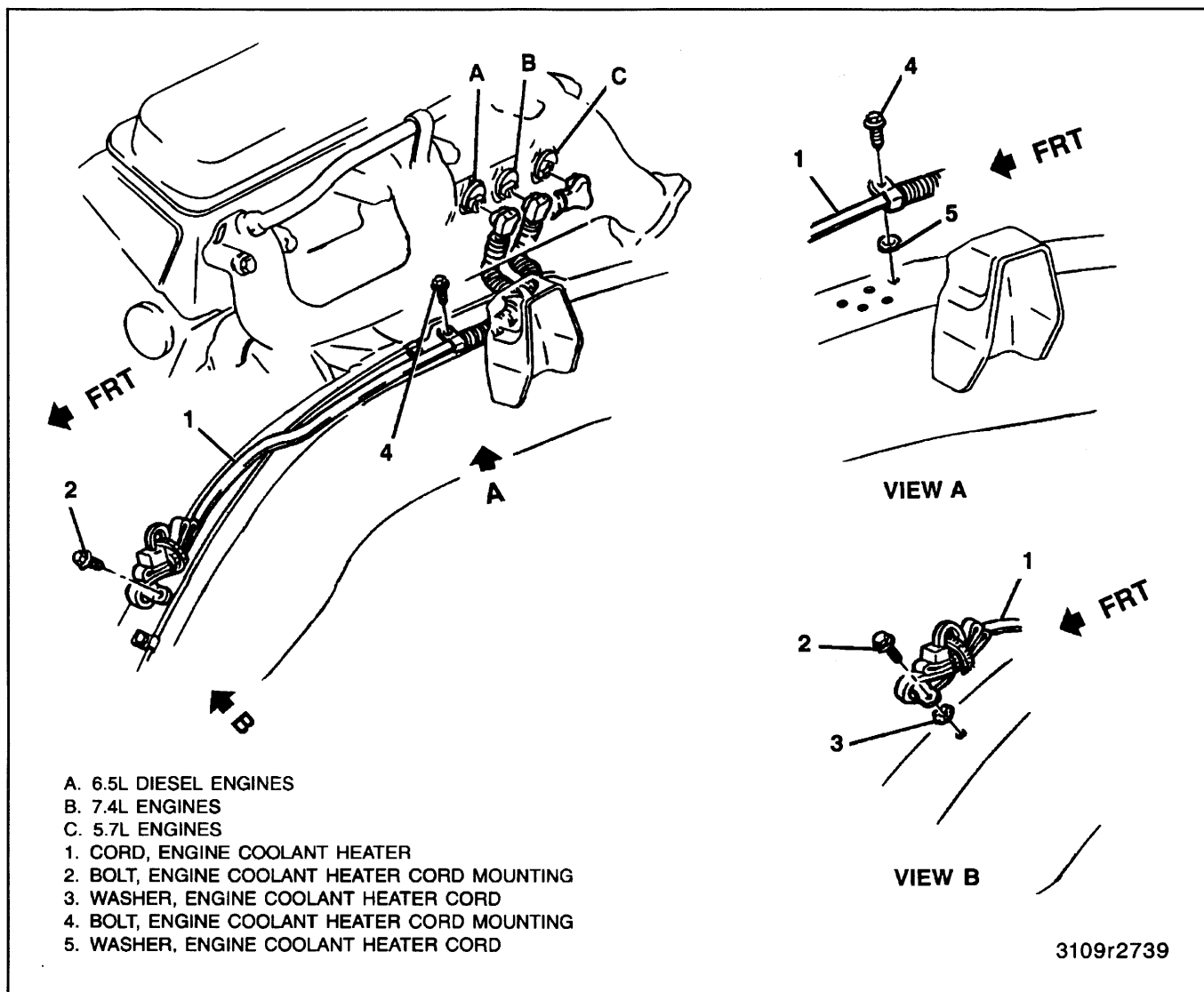


Figure 4—Engine Coolant Heater Cord Routing (Two-Wheel Drive - 1 Ton Models)

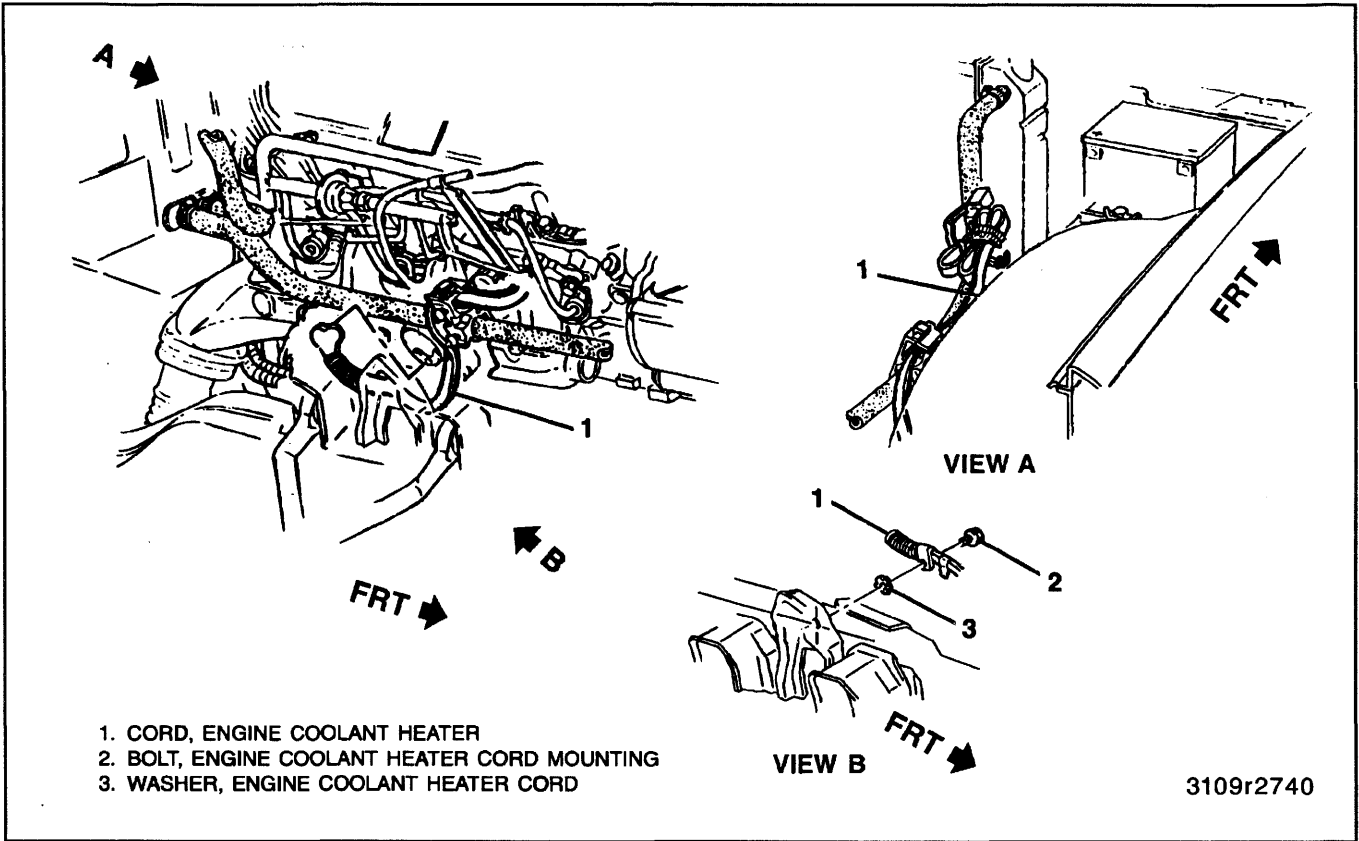


Figure 5—Engine Coolant Heater Cord Routing (Four-Wheel Drive Models with 7.4L Engine)

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Engine Coolant Heater Mounting Screw.....	1.8 N·m (16 lbs. in.)
Engine Coolant Heater Cord Mounting Screw.....	8 N·m (71 lbs. in.)
	T2714

NOTES

SECTION 9F

LUGGAGE CARRIER

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Fastener Tightening Specifications.....	9F-4

GENERAL DESCRIPTION

The luggage carrier is available as a dealer-installed option. Skid strips and support mounting anchor nuts are installed at the factory. During predelivery operations, the dealer will complete assembly installation.

The following procedures are for complete replacement of a previously installed luggage carrier.

ON-VEHICLE SERVICE

LUGGAGE CARRIER REPLACEMENT



Assemble



Remove or Disconnect (Figures 1, 2, and 3)

1. Rubber side rail cap from the center rail support (figure 3).
2. Screws from the center supports (figure 3).
3. Screws from the end supports.
4. Luggage carrier from the roof.
5. Center rail supports.
6. Side and center rail support gaskets.



Disassemble

1. Remove screws from the side rail supports (figure 1).
2. Side rail supports from the side rails.
3. Remove screws from the cross rails.
4. Cross rails from the sliders.
5. Screws from the sliders and the lock plates.
6. Sliders from the slots in the side rails.

NOTICE: For steps 2, 4, and 6, refer to "Notice" on page 9F-1.

1. Sliders into the slots in the side rails.
2. Screws into the sliders and the lock plates.



Tighten

- Slider to the side rail screws to 2.8 N·m (25 lbs. in.).

3. Cross rails onto the sliders.
4. Screws to cross rails.



Tighten

- Cross rail screws to 1.9 N·m (17 lbs. in.).

5. Side rail supports to the side rails.
6. Screws to the side rail supports.



Tighten

- Side rail support screws to 1.9 N·m (17 lbs. in.).

9F-2 LUGGAGE CARRIER

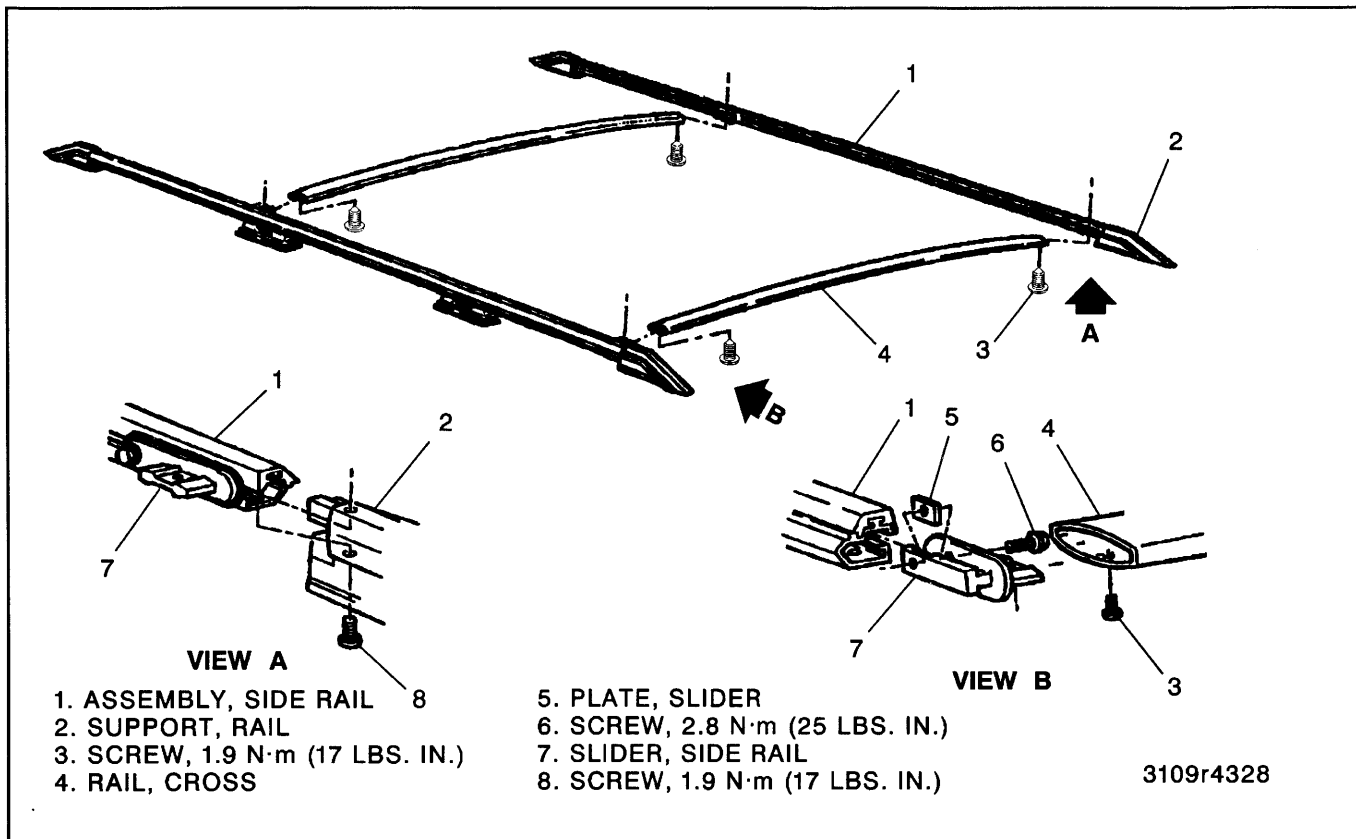


Figure 1—Luggage Carrier Components



Install or Connect (Figures 1, 2, and 3)

NOTICE: For steps 4 and 5, refer to "Notice" on page 9F-1.

1. Side and center rail support gaskets.
2. Center rail supports.
3. Luggage carrier onto the roof.
4. End support to the vehicle screws.



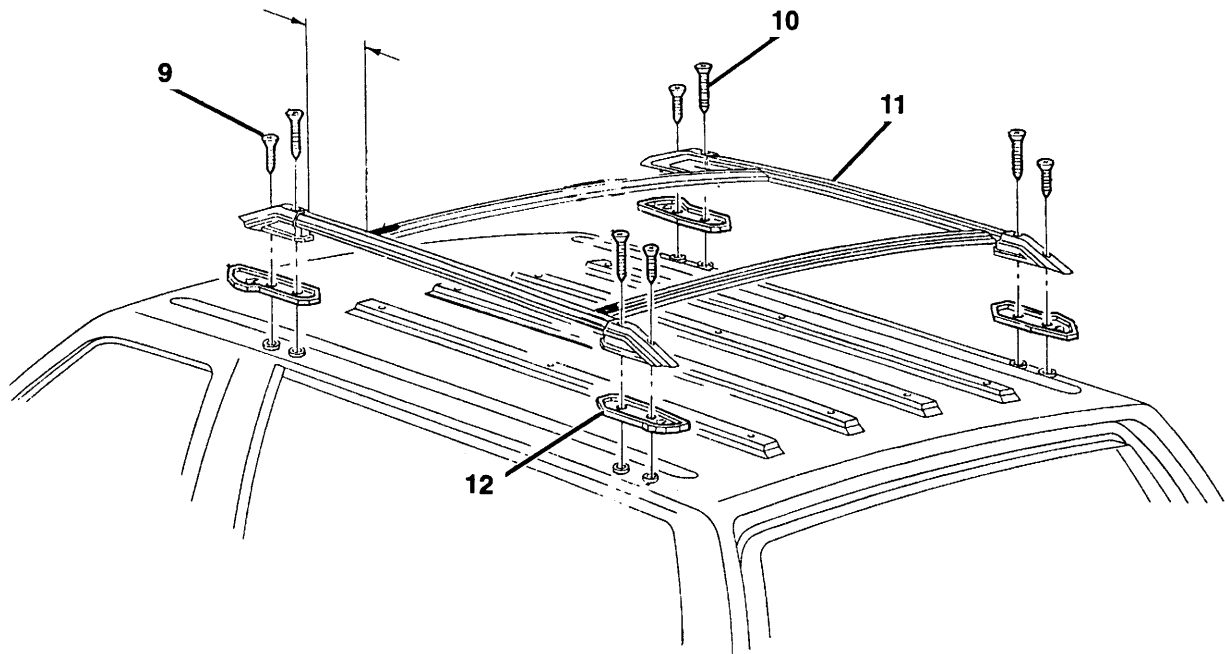
Tighten

- End support screws to 2.8 N·m (25 lbs. in.).
- 5. Screws into the center supports.



Tighten

- Center support screws to 2.8 N·m (25 lbs. in.).
- 6. Rubber side rail cap to the center rail support.



- 9. SCREW, LUGGAGE CARRIER MOUNTING
- 10. SCREW, LUGGAGE CARRIER MOUNTING
- 11. CARRIER, LUGGAGE
- 12. GASKET, SIDE RAIL SUPPORT

V3426

Figure 2—Luggage Carrier (Utility)

9F-4 LUGGAGE CARRIER

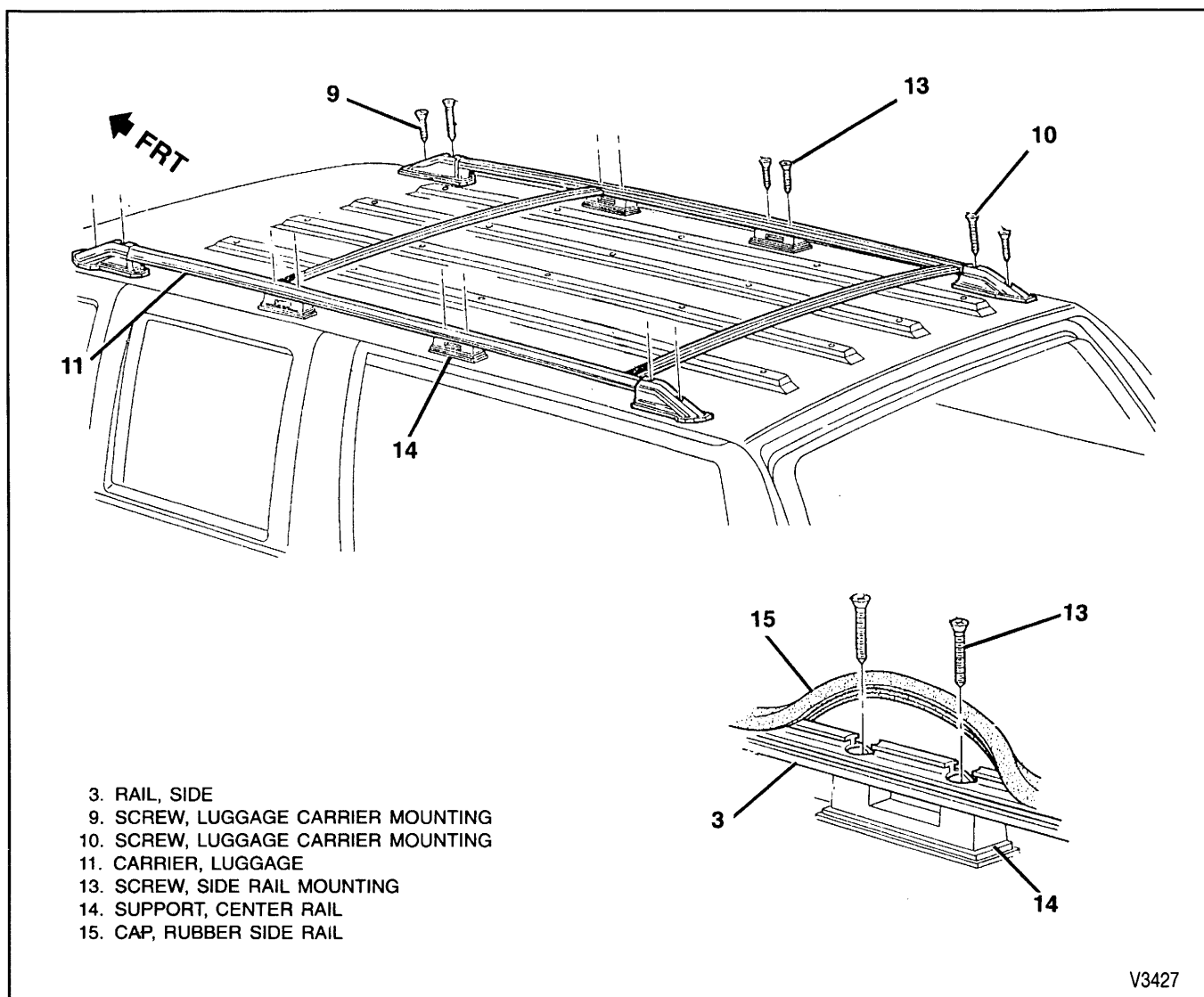


Figure 3—Luggage Carrier (Suburban)

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Cross Rail-to-Side Rail Slider Screw	1.9 N·m (17 lbs. in.)
Side Rail Support-to-Side Rail Screw	1.9 N·m (17 lbs. in.)
Side Rail-to-Body Mounting Screw	2.8 N·m (25 lbs. in.)

T2715

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SECTION 10A1**DOORS**

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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10A1-2 DOORS

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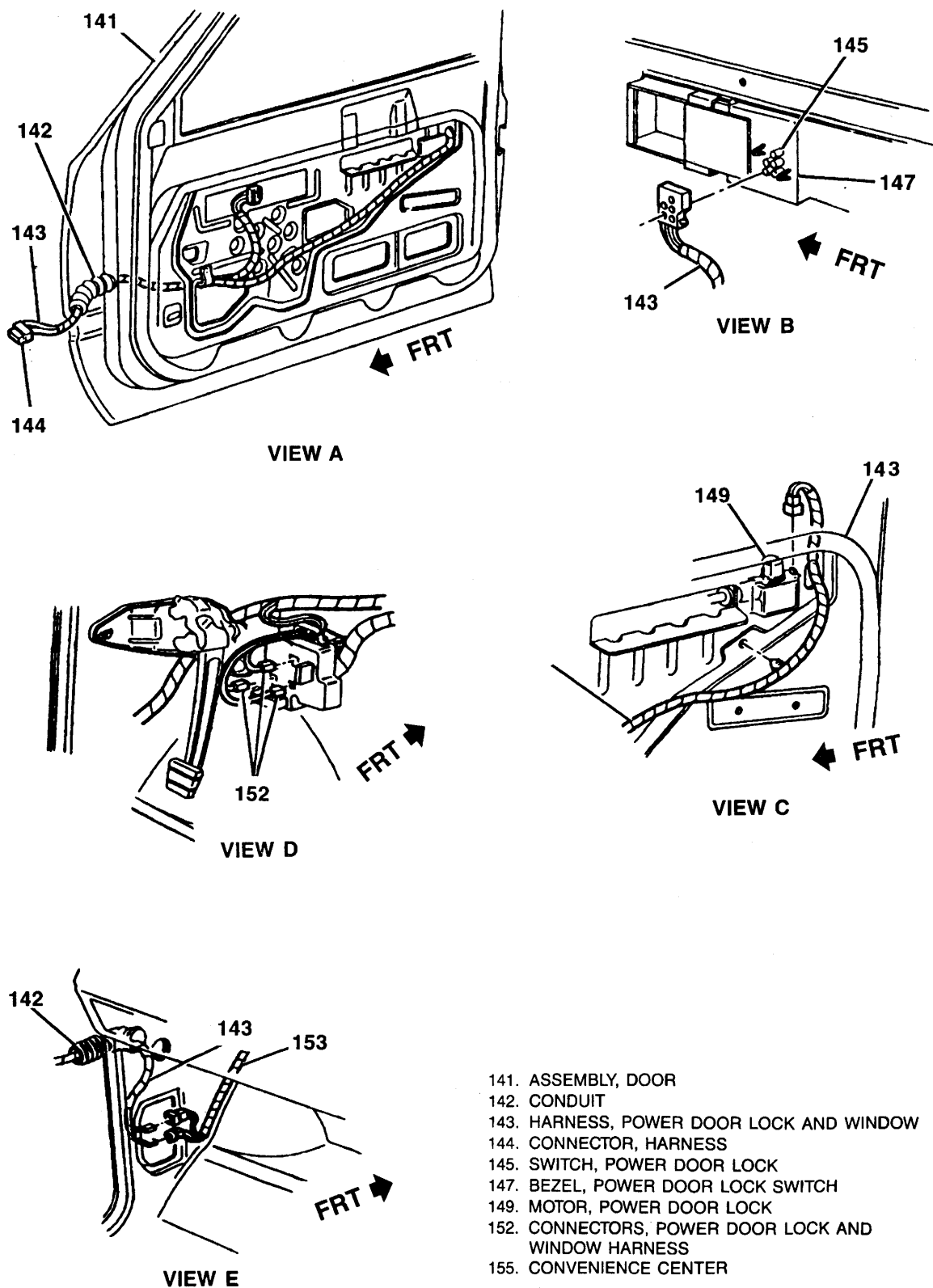
<u>SUBJECT</u>	<u>PAGE</u>
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GENERAL DESCRIPTION

The doors on C/K model trucks use hinges that are welded to the door and body. No adjustment of this type of hinge is recommended. Replacement hinges bolt on to the door pillar and body side pillar and are adjustable.

POWER DOOR LOCK AND POWER WINDOW HARNESS

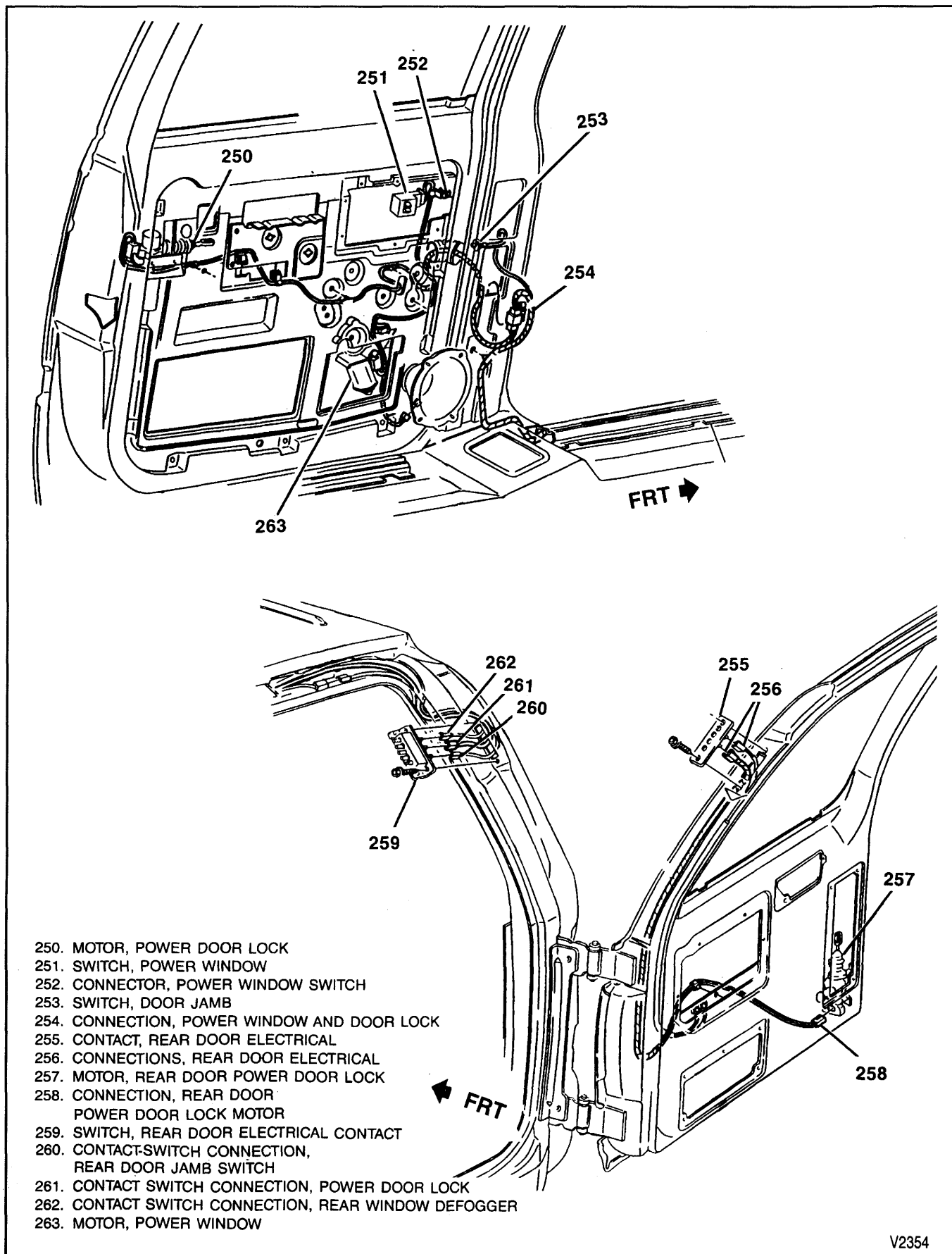
The power lock and window harness starts at the fuse block and routes to the left and right sides of the instrument panel. The harness travels to a set of connectors on the inner wheel housing. From the connectors, the harness passes through a flexible conduit tube in the front door trim panel opening. The harness branches off to the control switches, the door lock motors, and the power window motors inside the door (figures 1 and 2).



V2353

Figure 1—Power Door Lock and Window Harness

10A1-4 DOORS



V2354

Figure 2—Power Door Lock and Window Harness

DIAGNOSIS OF POWER WINDOW SYSTEM

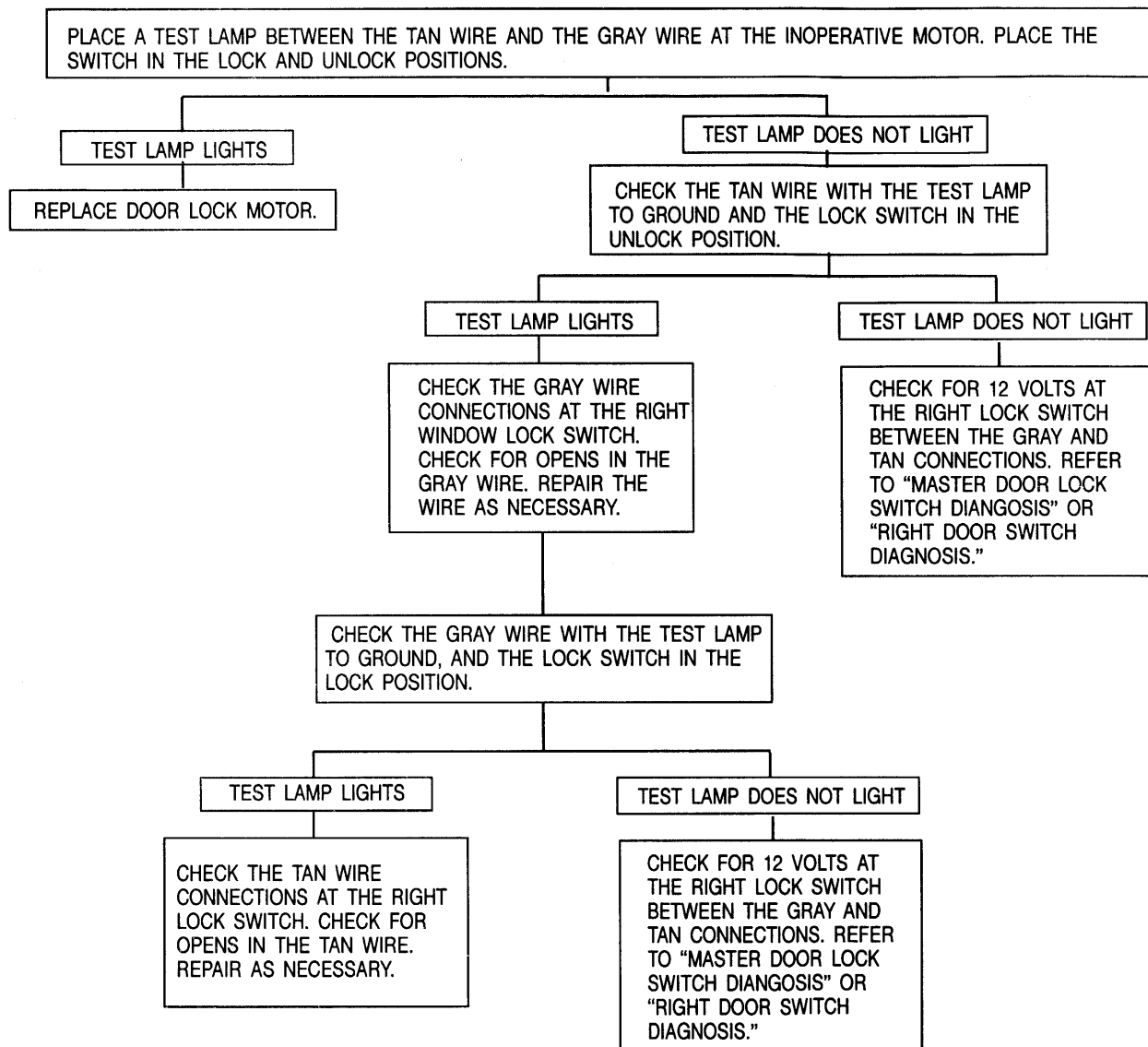
PROBLEM	POSSIBLE CAUSE	CORRECTION
Passenger Window Will Not Work, Using Either Passenger Switch or Driver Switch	1. No power at the passenger switch. 2. Passenger switch is not working. 3. Motor has an internal open.	1. Ignition switch at RUN or ACC. Check for voltage at the passenger switch. If there is no voltage, find the open between the switch and the fuse block. 2. With the voltage on the PNK wire at the switch, move the switch to "UP." There should be voltage at the switch. If there is no voltage, replace the switch. 3. With the window switch moved to the "UP" position, check for voltage on the DK BLU wire at the motor. If there is no voltage, find the open between the switch and the motor. If there is voltage on the DK BLU wire, backprobe a jumper ground at the BRN wire at the motor. If the motor does not run, replace the motor. If the motor does run, find the open in the ground circuit. Note: The ground circuit does run back through the passenger window "DN" contacts and the driver window switch "DN" contacts before reaching ground.
Passenger Window Will Not Work Using the Passenger Switch. The Window Will Work Using the Driver Switch	1. No power at the passenger switch. 2. Switch has internal open.	1. Check for voltage on the PNK wire at the passenger switch. If voltage is not present, find the open in the circuit between the switch and the instrument panel harness connector. 2. If voltage is present, replace the switch.
Passenger Window Won't Work Using The Driver Switch	1. No power. 2. Open in driver switch. 3. Open in harness.	1. Check driver window action. If the driver window works, power is at the switch. 2. With the driver switch moved to "UP," check for voltage on the DK BLU wire at the driver switch. If voltage is not present, replace the switch. 3. With voltage present on the DK BLU wire at the driver switch, find the open between the driver switch and the passenger switch.
Driver Window Won't Work — Passenger Window Works	1. Switch won't work. 2. Motor has internal open. 3. Motor ground circuit is open.	1. Switch moved to "UP." Check for voltage at the DK BLU wire at the switch. If voltage is not present, replace the switch. 2. Switch moved to "UP." Check for voltage on the DK BLU wire at the motor. If voltage is present, backprobe a jumper ground at the BRN wire at the motor. If the motor won't run, replace the motor. 3. Backprobe a jumper ground at the BRN wire at the motor. Move the driver switch to "UP." If the motor runs, find the open in the ground circuit.
D0140		

DIAGNOSIS OF POWER DOOR LOCK SYSTEM

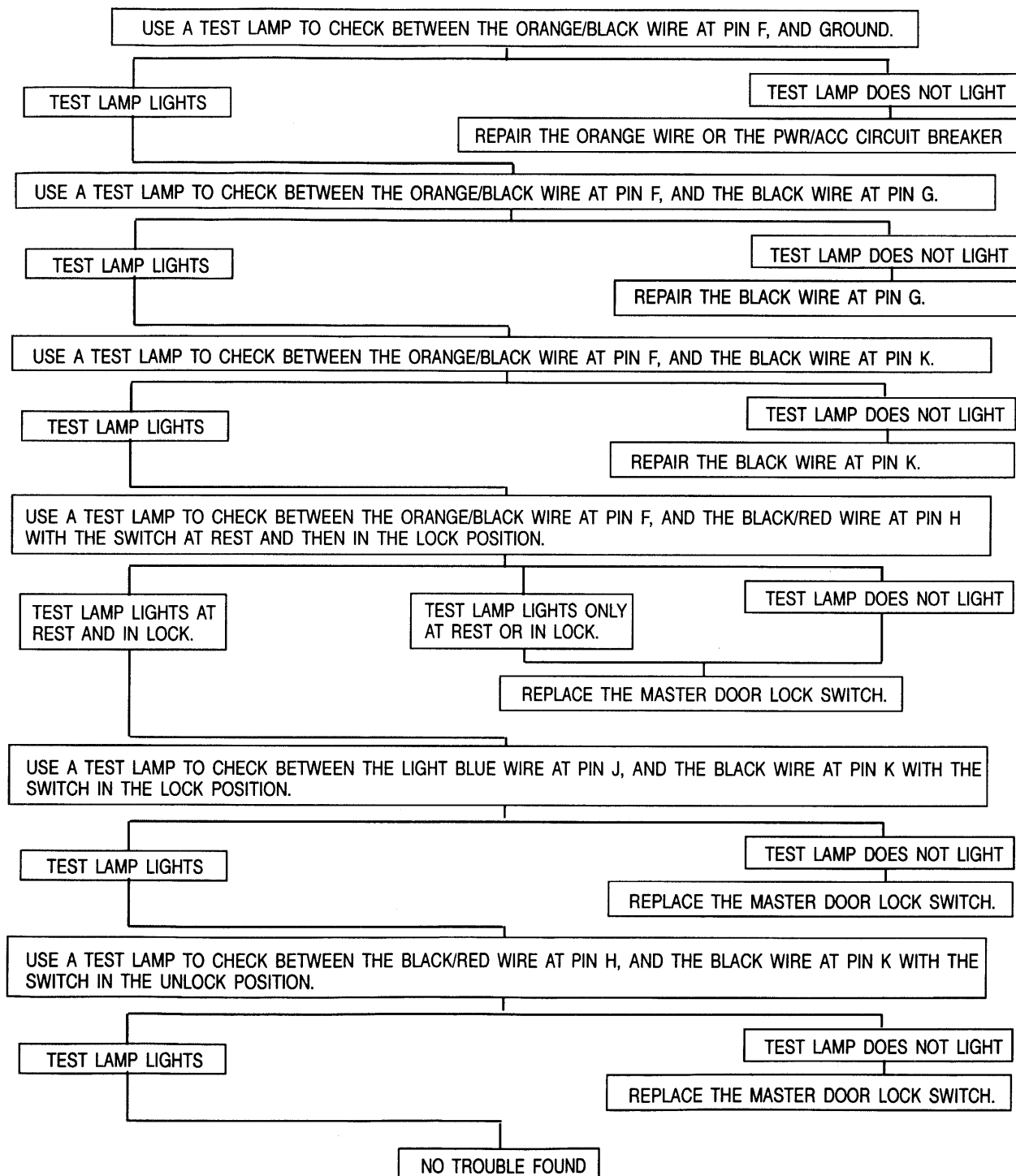
PROBLEM	POSSIBLE CAUSE	CORRECTION
One Door Locks and Unlocks. The Other Door Lock Is Inoperative.	1. Door lock motor.	1. Refer to "Door Lock Motor Diagnosis." Replace motor if necessary.
Neither Door Lock Works.	1. Master door lock switch. 2. Right door lock switch.	1. Refer to "Master Door Lock Switch Diagnosis." Replace switch if necessary. 2. Refer to "Right Door Lock Switch Diagnosis." Replace switch if necessary.
Neither Door Lock Works from the Master Door Lock Switch, and Both Operate From the Right Door Lock Switch.	1. Master door lock switch.	1. Refer to "Master Door Lock Switch Diagnosis." Replace switch if necessary.
Neither Door Lock Works from the Right Door Lock Switch, and Both Operate from the Master Door Lock Switch.	1. Right door lock switch.	1. Refer to "Right Door Lock Switch Diagnosis." Replace switch if necessary.

D0207

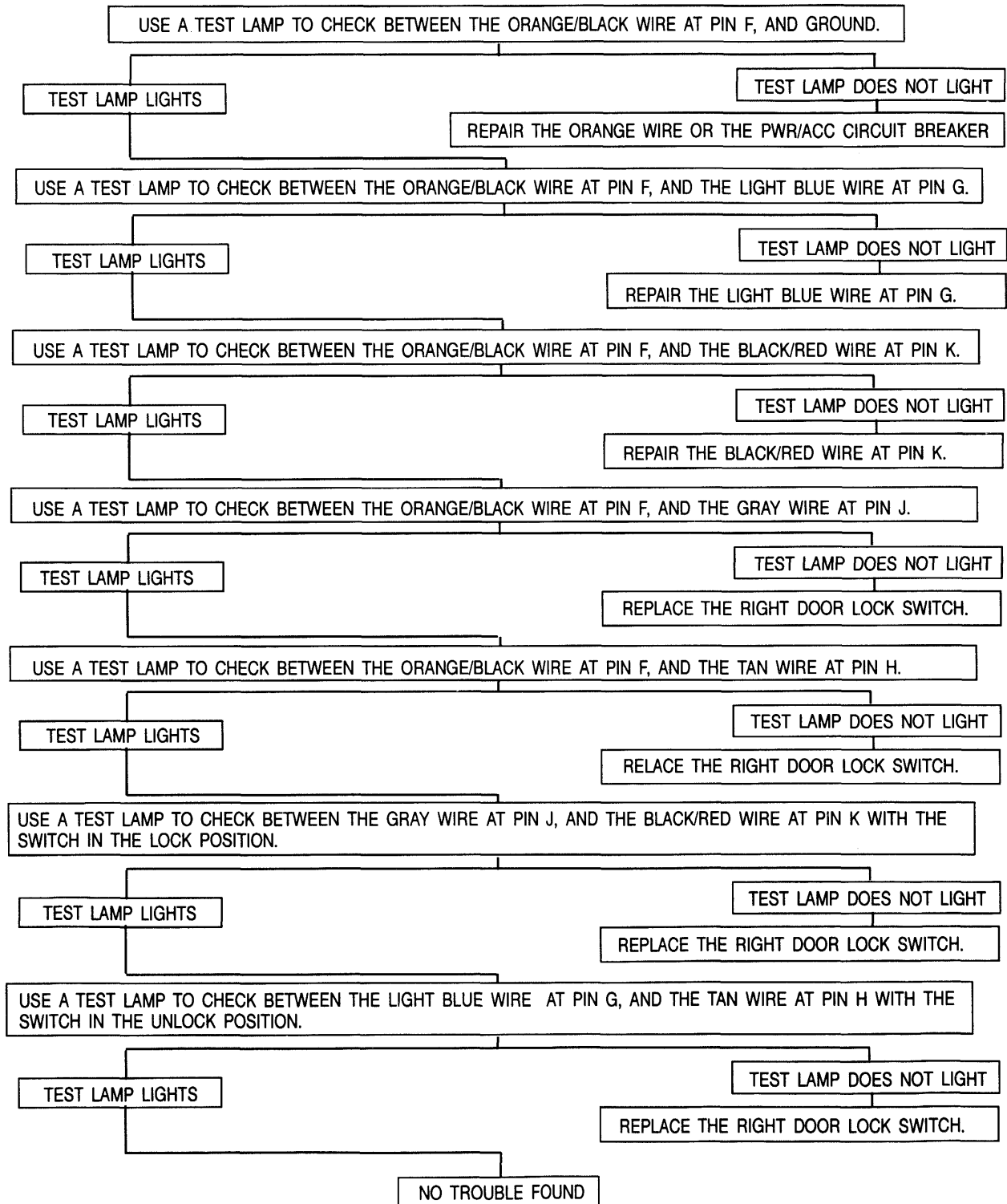
POWER DOOR LOCK MOTOR DIAGNOSIS



MASTER DOOR LOCK SWITCH DIAGNOSIS



PASSENGER DOOR LOCK SWITCH DIAGNOSIS



ON-VEHICLE SERVICE

DOOR REPLACEMENT

↔ Remove or Disconnect (Figures 3, 4, and 5)

Tools Required:

J 36604 Door Hinge Spring Compressor

VEHICLES WITH POWER DOOR COMPONENTS ONLY:

1. Negative battery cable. Refer to SECTION 0A.
2. Cowl side vent cover.
3. Wire harness connectors under the instrument panel.
 - A. Receptacles from the wire harness.
 - B. Retainer from the wire harness grommet.
 - C. Rubber conduit from the door pillar by pushing it from the vent cover side.

ALL VEHICLES:

- Apply cloth backed tape to the door and the body pillar.

CAUTION: Before removing the door hinge spring, cover the spring with a towel to prevent the spring from "flying" and possibly causing personal injury or damage.

4. Door hinge spring using J 36604 (figure 5).
 - Insert the blades of the tool between the spring coils and turn the barrel nut to compress and hold the spring during removal.
5. Lower hinge pin retainer.
6. Lower hinge pin using a soft-faced hammer and a pair of locking pliers to grasp the pin and drive it out.
 - Install a bolt through the lower hinges temporarily to hold the door in place while removing the upper hinge pin.
7. Upper hinge pin retainer.
8. Upper hinge pin.

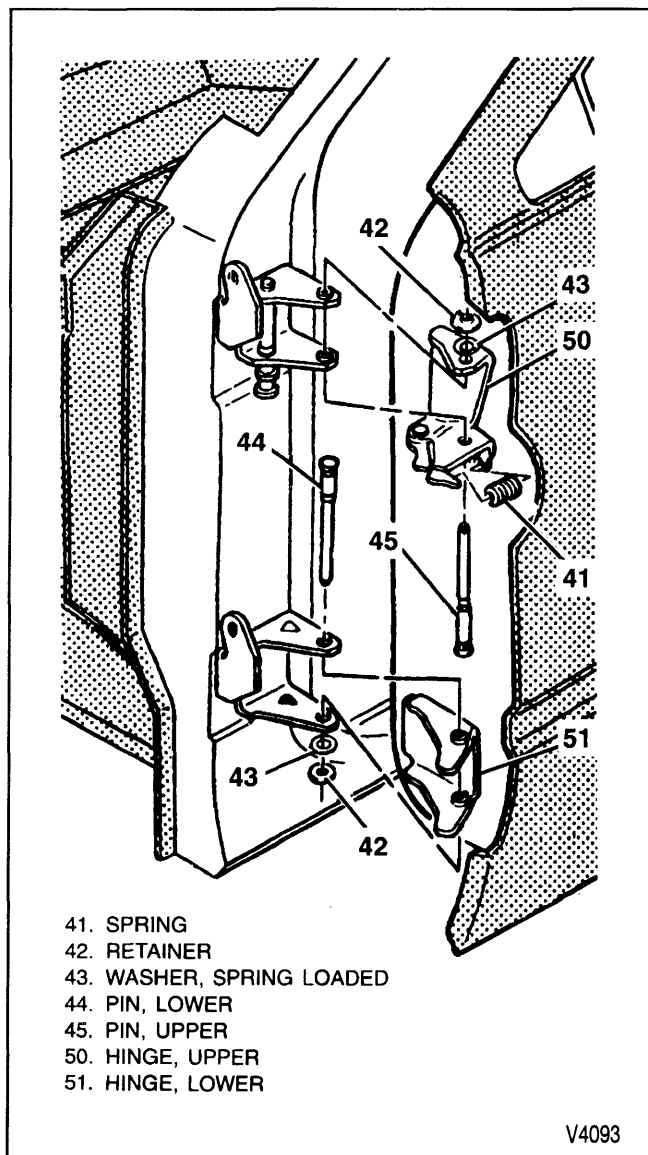


Figure 3—Front Door Hinge Components

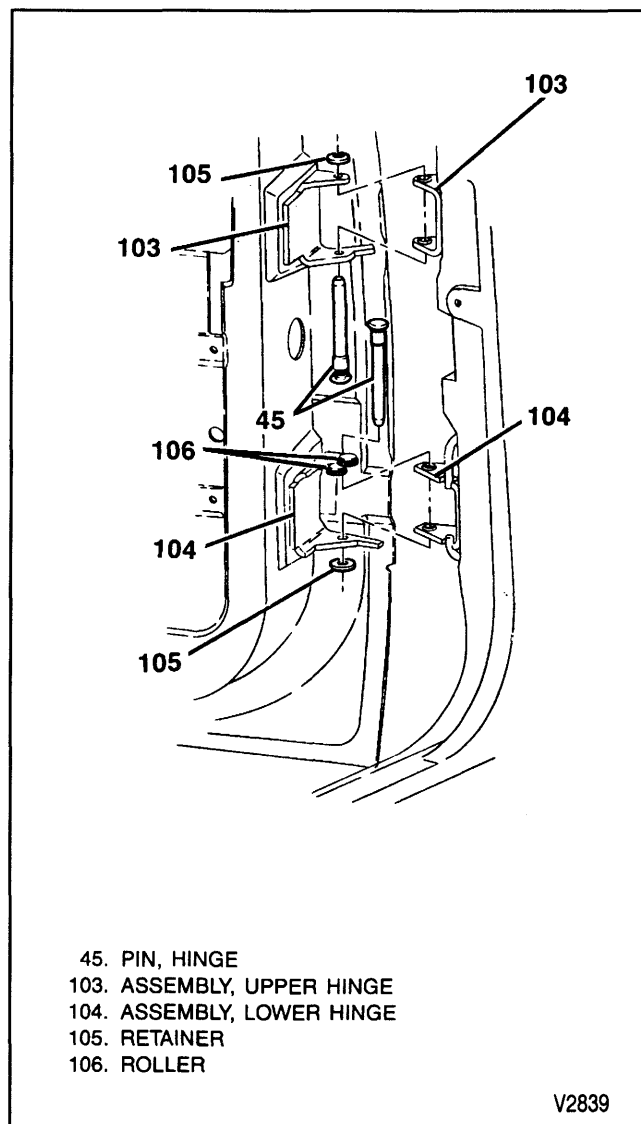


Figure 4—Rear Side Doors and Cargo Door Hinge Components

9. Bolt in lower hinge pin hole.
10. Door from the vehicle.

Install or Connect (Figures 3, 4, and 5)

Tool Required:
J 36604 Door Hinge Spring Compressor.
ALL VEHICLES:

1. Door to the vehicle.
2. Bolt temporarily through the lower hinge pin holes.
3. Upper hinge pin with the pointed end up.

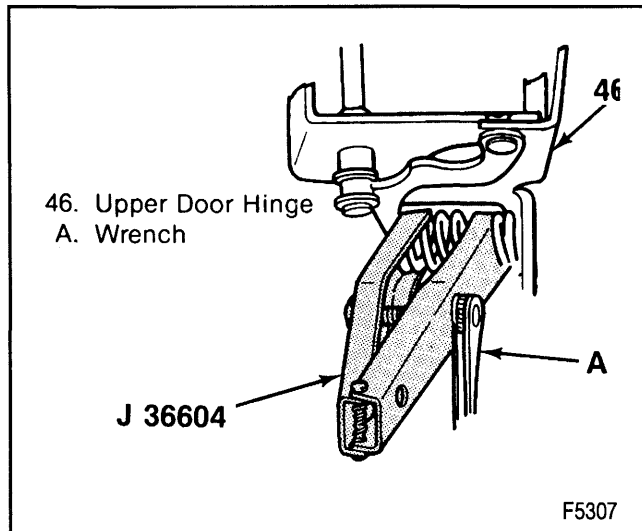


Figure 5—Hinge Spring Removal

4. New hinge pin retainer.
 - Remove temporary bolt from the lower hinge.
5. Lower hinge pin with the pointed edge down.
6. New hinge pin retainer.
7. Door hinge spring using J 36604 (figure 5).
VEHICLES WITH POWER DOOR COMPONENTS:
 8. Harness connectors.
 - A. Rubber conduit through the body pillar.
 - B. Retainer around the wire harness grommet.
 - C. Receptacles to the harness under the instrument panel.
9. Cowl side vent cover.
10. Negative battery cable.
11. Lubricate bushing with engine oil.

DOOR HINGE REPLACEMENT

Remove or Disconnect (Figure 6)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Door module panel.
3. Door. Refer to "Door Replacement."
4. Hinges from pillar or door.
 - A. Scribe the location of the existing hinges on the body pillar, and the door.
 - B. Center punch each of the weld marks on the original hinges. It is critical to punch the center of the weld so only the weld is removed.

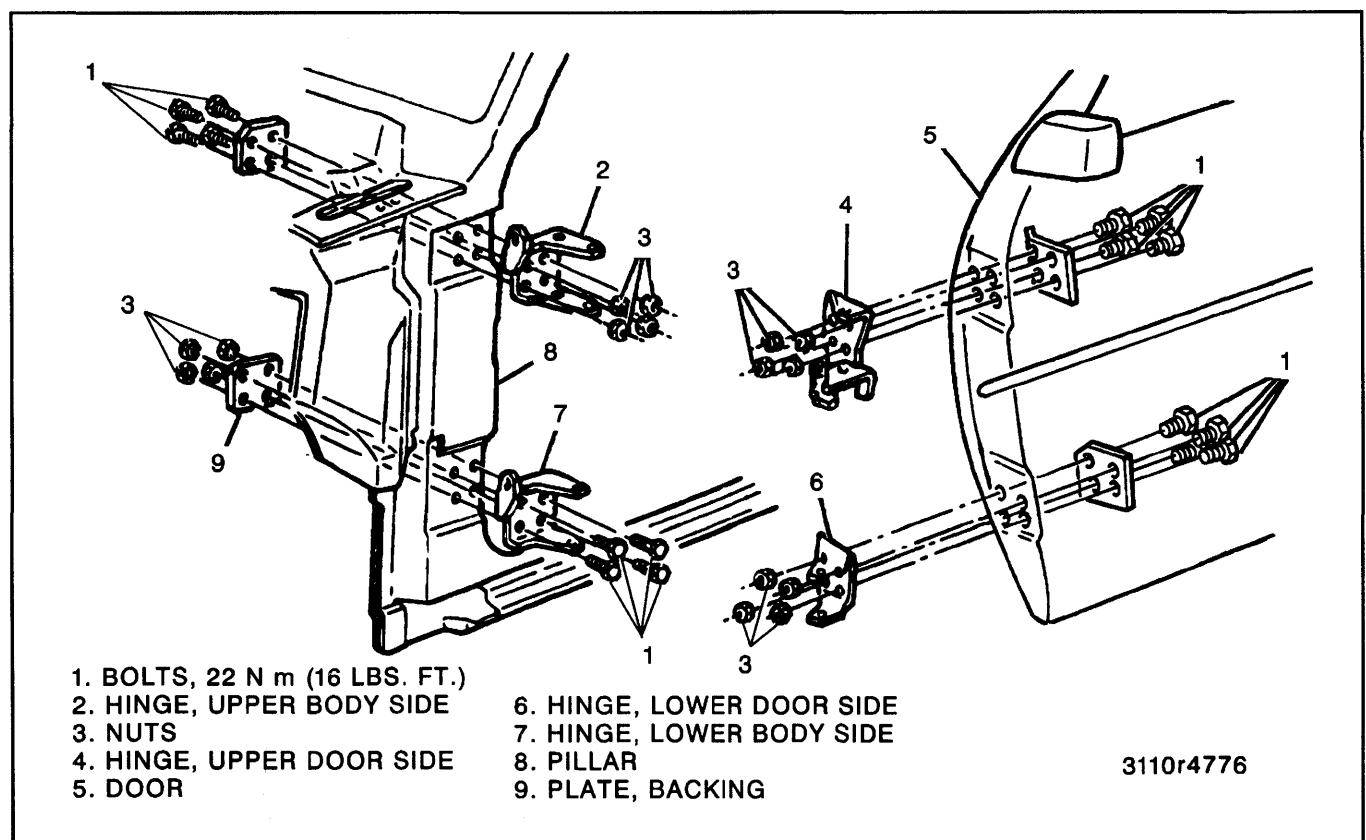


Figure 6—Replacement Hinges

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- C. Drill a 3-mm (1/8-inch) pilot hole through the hinge base only. Using the 3-mm hole as a pilot, drill a 13-mm hole (1/2-inch) hole through the hinge base only. This will remove the weld, without drilling through the pillar or the door.
- D. Drive a chisel between the hinge and pillar or the door to separate the hinge from the pillar or door.

Left Hinge Replacement:

1. Sill plate.
2. Kick pad by lifting from the retainers.
3. Parking brake assembly. Refer to SECTION 5F.
 - Carefully pry away the cowl side panel insulator over the lower access hole and set aside to reuse.

Right Hinge Replacement:

1. Negative battery cable. Refer to SECTION 0A.
2. Sill plate.
3. Kick pad by lifting from the retainers.
4. Glove compartment.
5. Engine control module (ECM) from the mounting bracket by lifting it from the retainers.
6. ECM mounting bracket and screws.
 - Carefully pry the cowl side panel insulator away from the lower access hole and set aside to reuse.

Install or Connect (Figure 6)

1. Hinges to pillar or door.
 - A. Position the bolt-on service replacement hinges within the scribe marks made on the body hinge pillar and the door at the time of removal.
 - B. Center punch each bolt hole location on the body hinge pillar and/or door.
 - C. Drill a 13-mm (1/2-inch) hinge attaching hole in three steps to ensure placing the hinge in the proper position.
2. Prepare the surface for the replacement hinges using a file or equivalent.
 - Coat the mating surface of the hinges with a medium bodied sealer.

NOTICE: Refer to "Notice" on page 10A1-1.

3. Hinges, backing plate, bolts, and nuts.
 - A. Align the hinge and backing plate with the holes in the hinge pillar and door.
 - B. Place the bolts through the hinge, pillar and/or door, and through the backing plate.

Tighten

- Nuts to 35 N.m (26 lbs. ft.).

Left Side:

1. Cowl side panel insulator over the lower access hole.
2. Parking brake assembly. Refer to SECTION 5A.
3. Kick pad and sill plate.

Right Side:

1. Cowl side panel insulator over the lower access hole.
2. Engine control module (ECM) mounting bracket and screws.
3. ECM.
4. Glove compartment.
5. Kick pad and sill plate.
6. Door to the cab. Refer to "Door Replacement."
7. Door module panel. Refer to "Door Module Replacement."
8. Door trim panel. Refer to "Door Trim Panel Replacement."
9. Negative battery cable.



Adjust

- Refer to "Door Adjustment."

DOOR ADJUSTMENT

This procedure can only be used when bolt-on service replacement hinges are installed.



Remove or Disconnect (Figures 7 and 8)

Tool Required:

J 29843-9 Torx Bit (Bit Size T47) or equivalent.

- Door striker bolt using J 29843-9 or equivalent.
- Loosen the door hinge to the body side pillar bolts.



Adjust (Figure 7)

1. Door up or down, forward or rearward, and in or out at the door hinges.
2. Gap between the rocker panel and the door to the specifications shown in figure 7.
3. Gap between the door and the roof panel.
4. Gap between the rear of the door and the rear pillar.
5. Gap between the door and the fender.
6. Door surfaces flush with other panels within ± 1.0 mm (0.04-inch).

NOTICE: Refer to "Notice" on page 10A1-1.



Tighten

- Hinge bolts to 35 N.m (26 lbs. ft.).



Install or Connect (Figure 8)

Tool Required:

J 29843-9 Torx Bit (Bit Size T47).

NOTICE: Refer to "Notice" on page 10A1-1.

- Door striker bolt.

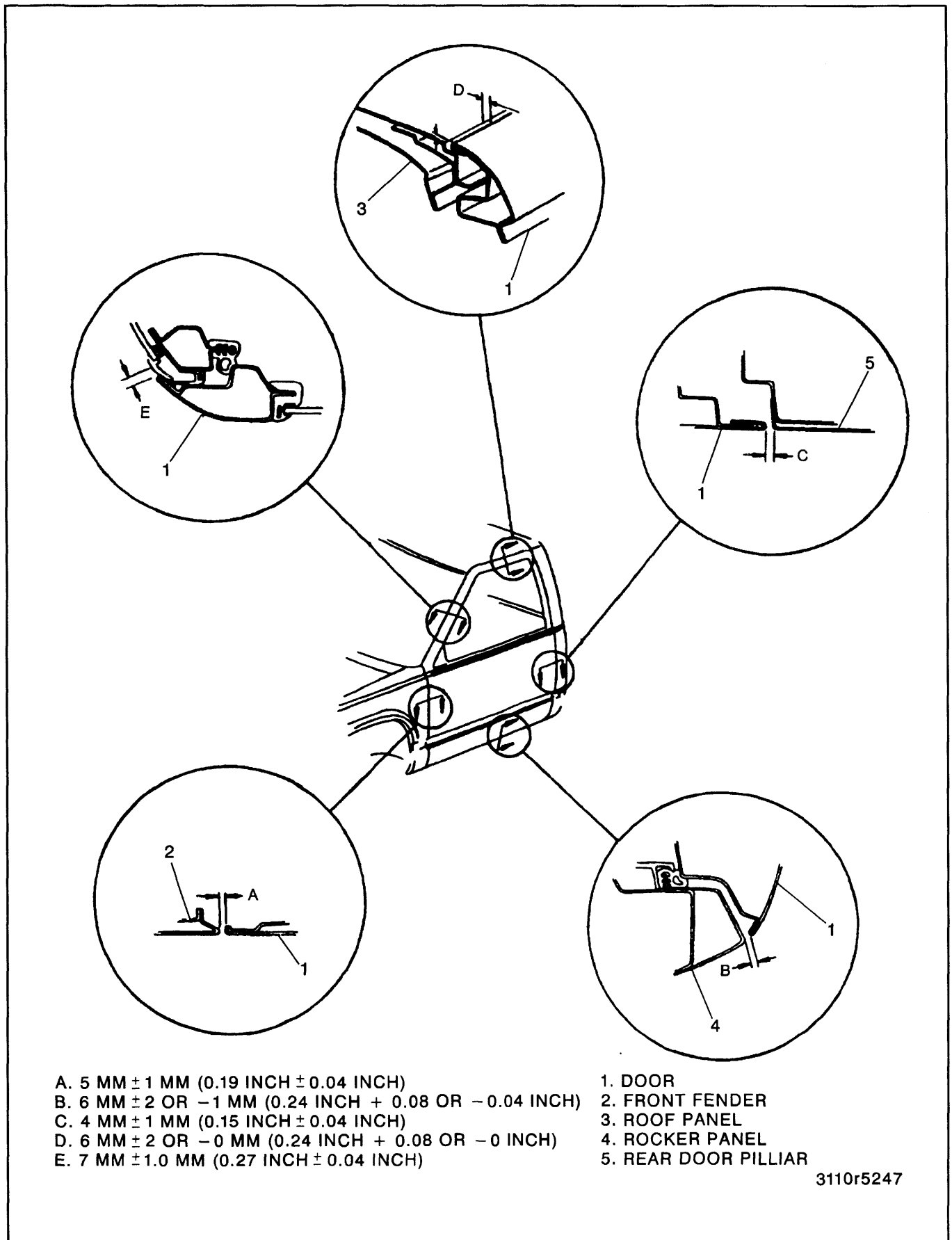


Figure 7—Door Adjustment

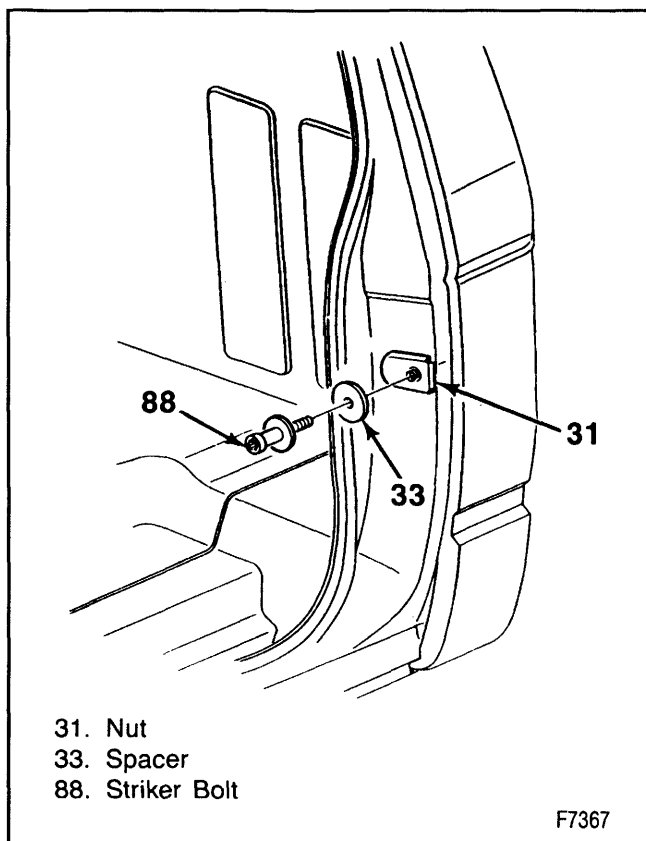


Figure 8—Door Striker Components



Adjust

- Bolt to properly engage the door lock.



Tighten

- Bolt to 63 N.m (46 lbs. ft.).

DOOR STRIKER BOLT REPLACEMENT

The door striker bolt is the special bolt and washer mounted on the door opening's rear pillar. The bolt passes through a hole into a threaded plate behind the pillar. The cab door is secured in position when the lock cam (arm) of the locking mechanism engages and snaps around the striker bolt.

The striker bolt position is not adjustable.



Remove or Disconnect (Figure 8)

Tool Required:

J 29843-9 Torx Bit (Bit Size T47)

1. Mark the position of the striker bolt spacer on the door pillar.
2. Striker bolt using J 29843-9 or equivalent.



Install or Connect (Figure 8)

NOTICE: Refer to "Notice" on page 10A1-1.

1. Striker bolt into the door pillar retaining plate.
2. Align the striker bolt spacer with the previously made mark.



Tighten

- Striker bolt while holding spacer in position to 63 N.m (46 lbs. ft.) using J 29843-9 or equivalent.

DOOR TRIM PANEL REPLACEMENT



Remove or Disconnect (Figure 9, 10, and 11)

Tool Required:

J 24595-C Trim Pad Retainer Clip Remover

J 9886-01 Door Handle Clip Remover

1. Trim panel pull strap (if used).
 - Remove the plug on each side of the strap and the screws underneath.
2. Door handle bezel.
3. Armrest screws.
4. Armrest pad.
5. Window handle (if used) with J 9886-01. Refer to "Window Regulator Handle Replacement."
6. Use J 24595-C to remove the retainers from the inner door panel.
7. Door trim panel.
8. Bezel with switches fit through cut-out in trim panel.



Install or Connect (Figures 9, 10, and 11)

1. Retainers to the door trim panel if any remained in the door. Replace any broken retainers.
2. Bezel with switches through cut-out in trim panel.
3. Door trim to the door.
 - Put the trim pad in place on the door and push the retainers into the holes on the door.
4. Window handle (if used). Refer to "Window Handle Regulator Replacement"
5. Armrest pad.
6. Armrest screws.
7. Door handle bezel.
8. Pull strap (if used).

WINDOW REGULATOR HANDLE REPLACEMENT

Tool Required:

J 9886-01 Door Handle Clip Remover.



Remove or Disconnect (Figure 12)

1. Window regulator handle.
 - A. Insert J 9886-01 between the handle and the bearing plate.
 - B. Align the tool J 9886-01 parallel with the door handle and push to disengage the spring clip.
 - C. Pull the handle from the door.
2. Bearing plate.

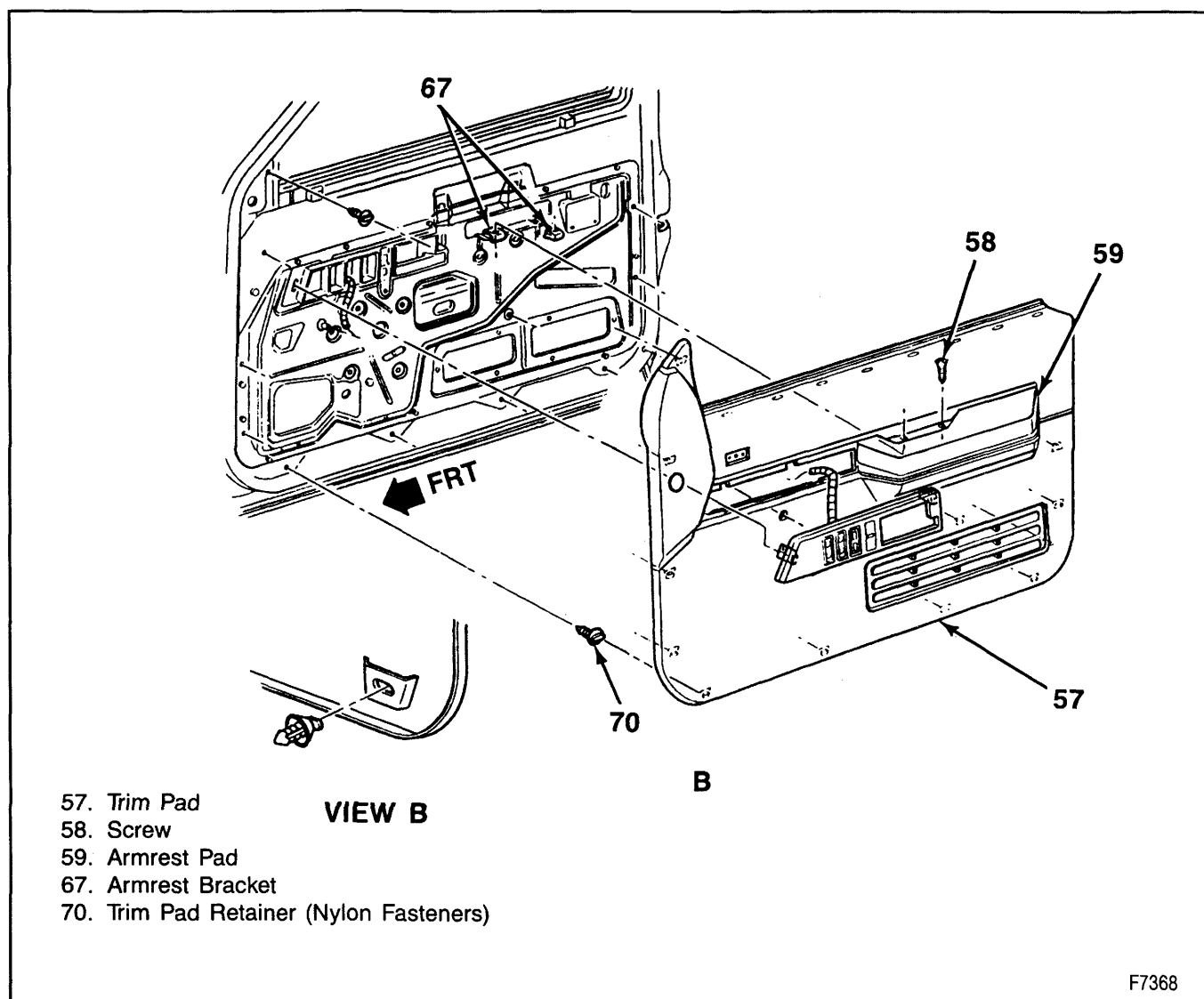


Figure 9—Front Door Trim Panel

**Install or Connect (Figure 12)**

1. Bearing plate.
2. Place the window in the raised position.
3. Put the spring clip onto the handle.
4. Insert the handle onto the door so the handle is pointing towards the front of the door.
 - Push on the handle until the spring clip engages the window regulator shaft.

INNER DOOR PANEL WATER DEFLECTOR REPLACEMENT

Water deflectors are used to seal the door inner panel and prevent water from entering into the body. The deflector is secured with a self sealing adhesive.

**Remove or Disconnect (Figure 13)**

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Water deflector by pulling it back from the door module.

**Install or Connect (Figure 13)**

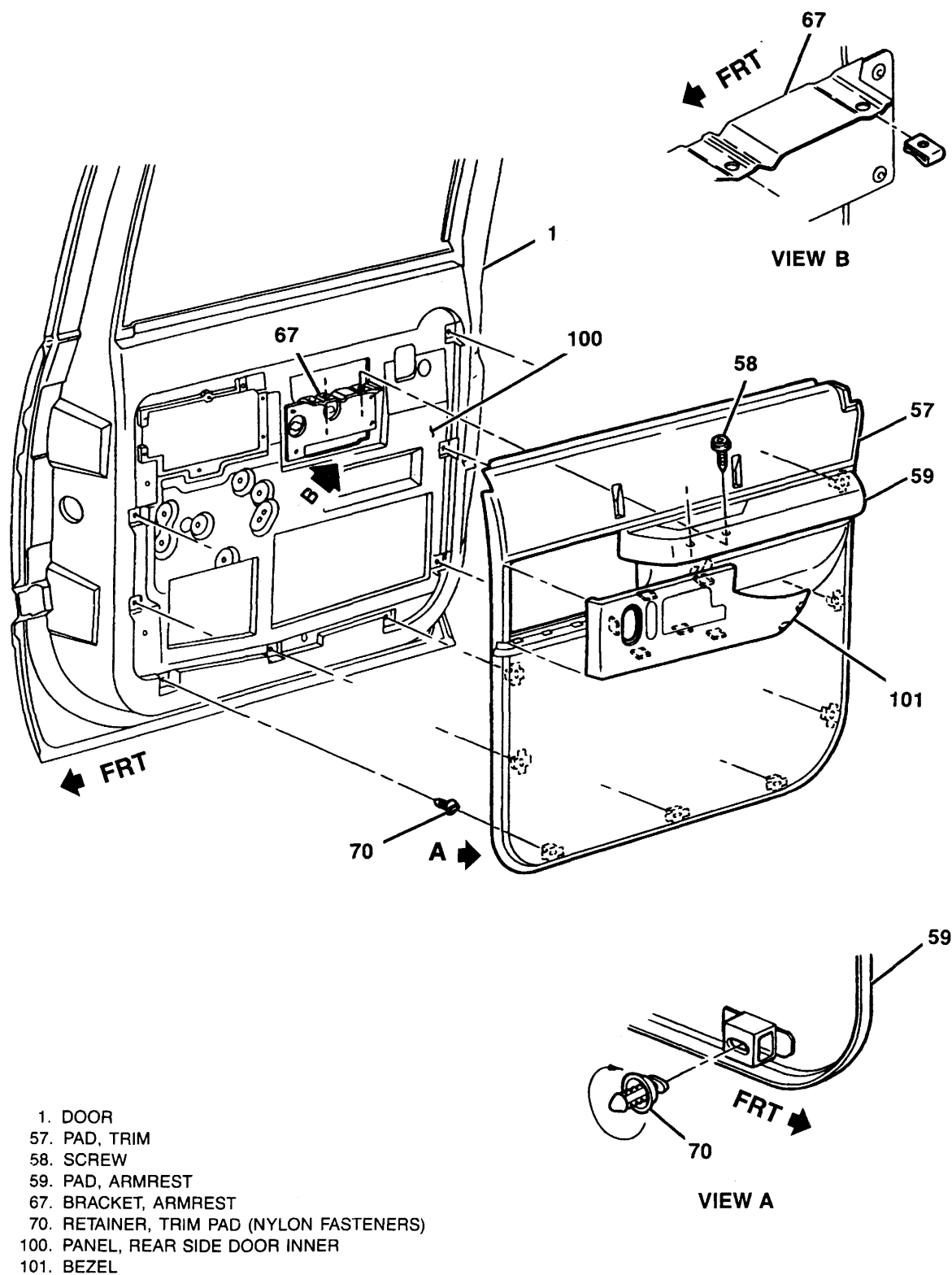
1. Water deflector by pressing it against the door module in the area of the adhesive to make a continuous seal.
 - A. Tuck the two lower tabs through slots in the door module.
 - B. Tape over tabs and slots.
2. Door trim panel. Refer to "Door Trim Panel Replacement."

PRESSURE RELIEF VALVE REPLACEMENT

DOOR MODULE VALVE**Remove or Disconnect (Figure 13)**

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Valve by drilling out the rivets.

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V2896

Figure 10—Rear Door Trim Panel

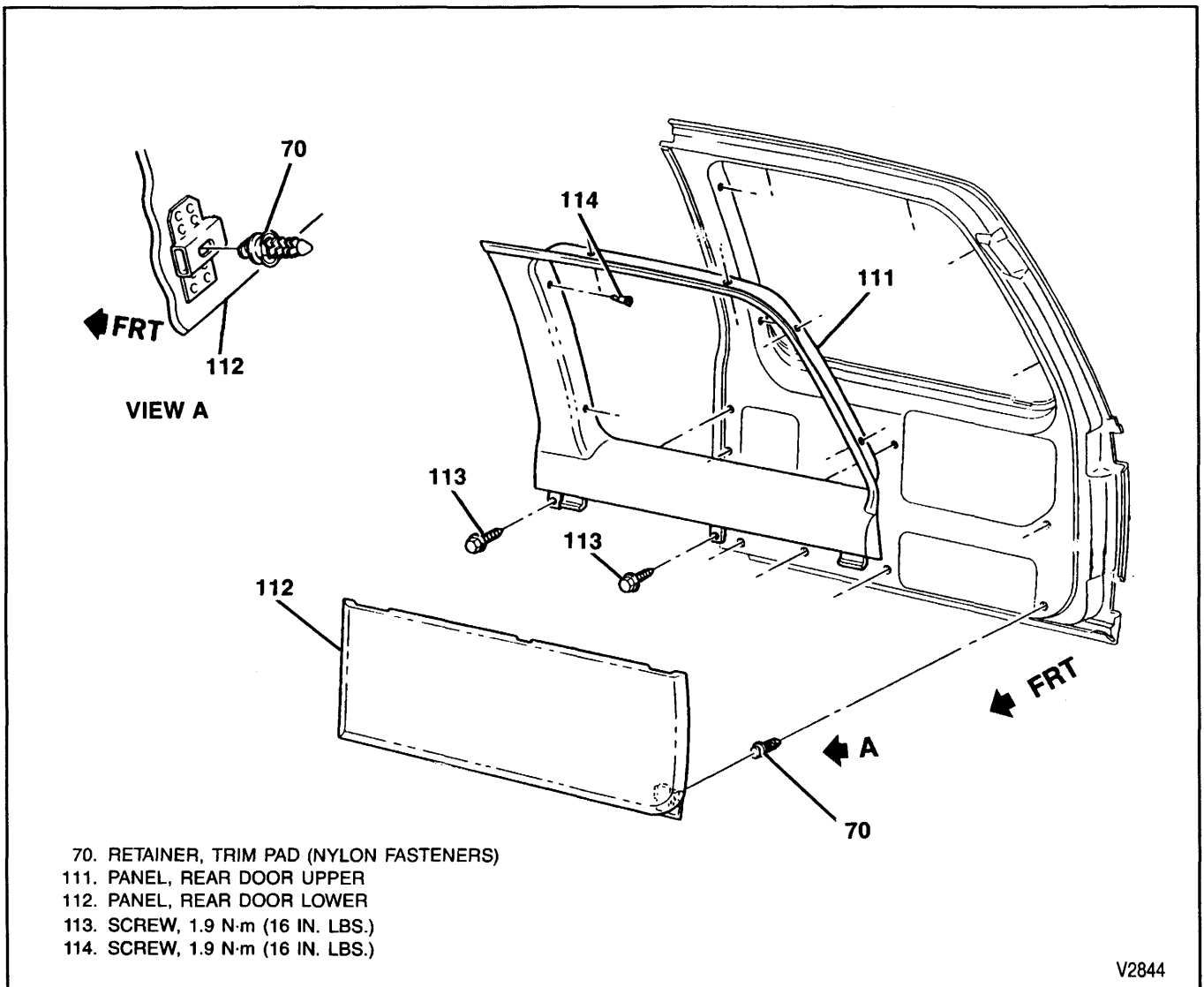


Figure 11—Cargo Door Trim Panel

Install or Connect (Figure 13)

1. Valve assembly to the door by riveting.
2. Door trim panel. Refer to "Door Trim Panel Replacement."

DOOR EDGE VALVE

Remove or Disconnect (Figure 14)

1. Screw retaining the assembly to the door.
2. Valve assembly by lifting it up.

Install or Connect (Figure 14)

1. Valve assembly to the door edge.

NOTICE: Refer to "Notice" on page 10A1-1.

Tighten

- Screw to 1.6 N·m (14 lbs. in.).

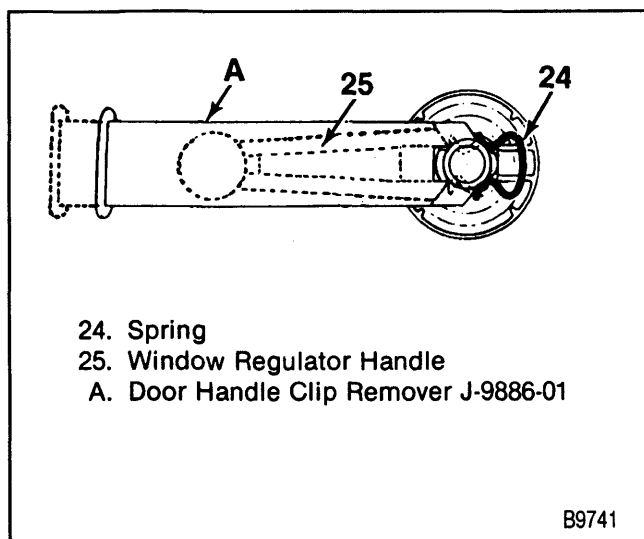


Figure 12—Window Handle Replacement

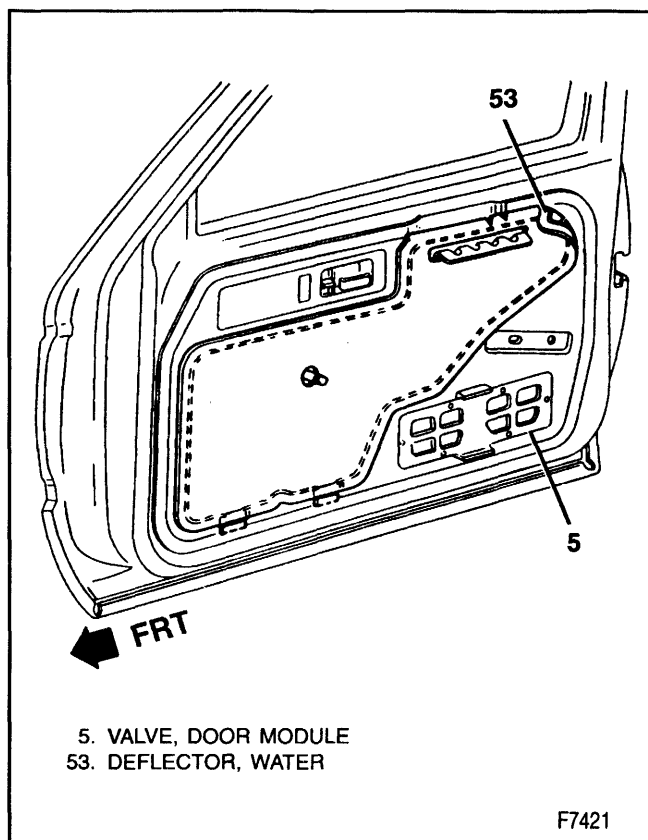


Figure 13—Inner Panel Water Deflector and Pressure Relief Valves

DOOR HARDWARE LUBRICATION

The mechanical components of the door assembly are lubricated during assembly. If additional lubrication is required to any door hardware mechanism, lubricate with Lubriplate Spray-Lube "A," or Lubriplate Auto-Lube "A," or equivalent. Door hinge pins and bushings should be lubricated at normal service intervals (3 months or 3000 miles) with 30-weight engine oil. Do not lubricate hinge roller to hold-open link contacting surfaces, as this may prevent the roller from rolling properly.

DOOR LOCK REPLACEMENT

↔ Remove or Disconnect (Figures 15 and 16)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Screws from the door module.
 - Tilt the module outward at the top.
3. Lock cylinder rod from the lock cylinder.
4. Inside lock rod.
5. Inside handle rod.
6. Lock screws.
7. Lock mechanism.

→→ Install or Connect (Figures 15 and 16)

1. Lock mechanism.
2. Outside door handle rod.

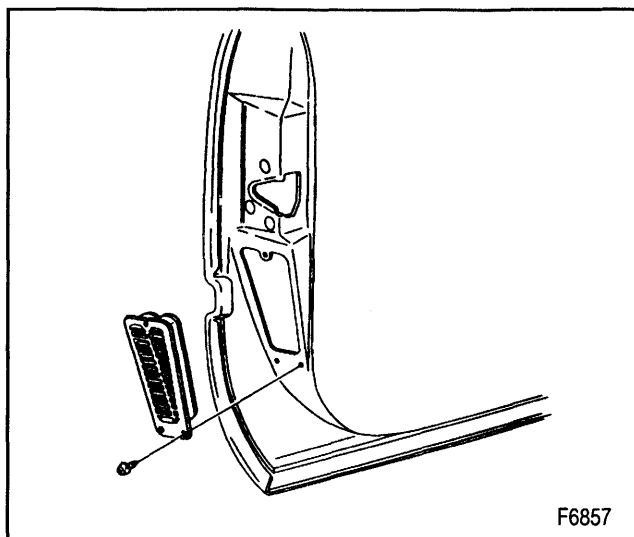


Figure 14—Pressure Relief Valve

NOTICE: Refer to "Notice" on page 10A1-1.

3. Lock screws.

⌚ Tighten

- Screws to 6.7 N·m (60 lbs. in.).
4. Lock cylinder rod to the lock cylinder.
 5. Inside lock rod.
 6. Inside door handle rod.
 - Tilt the door module back in position.
 7. Top front and then top rear module screws.
 8. Rest of the module screws.
 9. Door trim panel. Refer to "Door Trim Panel Replacement."

DOOR MODULE REPLACEMENT

↔ Remove or Disconnect (Figure 15)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
 - Lower the window all the way.
2. Screws holding the door module to the door.
 - Pull back the water deflector.
3. Lock and handle rods from the back of the door module.
 - Tape them to the door.
4. Module wiring connector (if present).
 - A. Pull the wiring from the door hinge pillar to reach the connector.
 - B. Remove the boot over the wiring.
 - C. Push the wiring harness into the door.
5. Upper belt through window run channel.
 - A. Move the channel away from the glass.
 - B. Tilt the module and window glass assembly, then lift it out of the bottom of the door.

→→ Install or Connect (Figure 15)

NOTICE: For steps 2, 6, 7, and 8, refer to "Notice" on page 10A1-1.

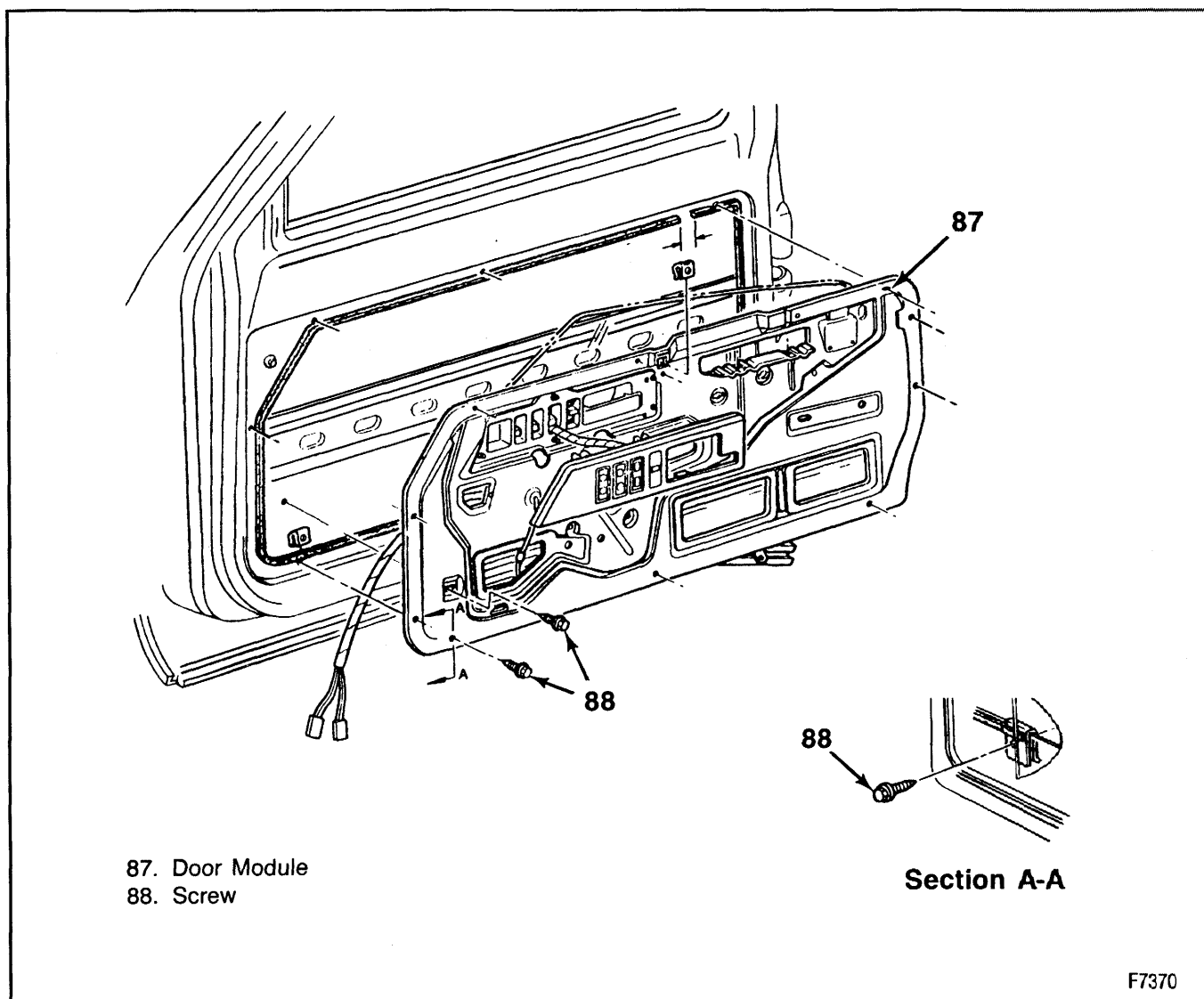


Figure 15—Door Module

1. Door module and glass assembly into the door.
 - Fit the glass into the rear channel inside the door.
2. Upper run channel bolt and tighten it.
3. Lock and handle rods to the back of the door module.
4. Wiring connector (if used).
 - Pull the wiring through the boot and connect it inside the door hinge pillar.
5. New water deflector. Refer to "Door Inner Panel Water Deflector Replacement."
6. Top front and the top rear door module screws.
7. Door module to door screws.
8. Lower run channel bolt.
9. Door trim panel. Refer to "Door Trim Panel Replacement."

POWER DOOR LOCK ACTUATOR REPLACEMENT

↔ Remove or Disconnect (Figure 17)

1. Negative battery cable. Refer to SECTION 0A.

2. Door trim panel. Refer to "Door Trim Panel Replacement."
3. Water deflector.
4. Module panel. Refer to "Door Module Replacement."
5. Lock actuator mounting rivets by drilling.
6. Remote lock rod from the actuator arm.
7. Wire harness from the lock actuator.
8. Actuator from the module panel.

↔ Install or Connect (Figure 17)

1. Module panel to actuator rivets.
2. Wiring harness to the actuator.
3. Remote lock rod to the actuator arm.
4. Module panel to the door.
5. Water deflector. Refer to "Inner Door Water Deflector Replacement."
6. Door trim panel. Refer to "Door Trim Panel Replacement."
7. Negative battery cable.

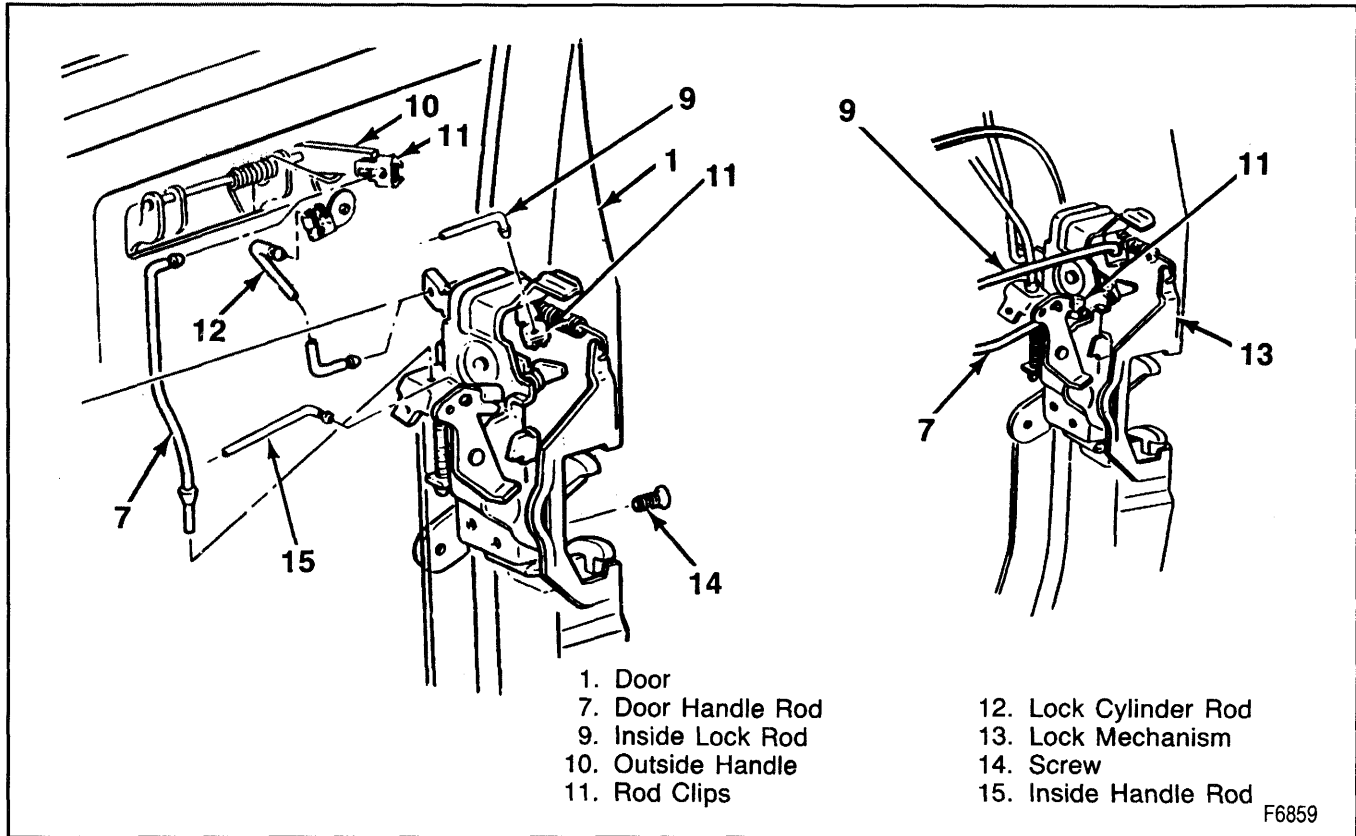


Figure 16—Door Lock Components

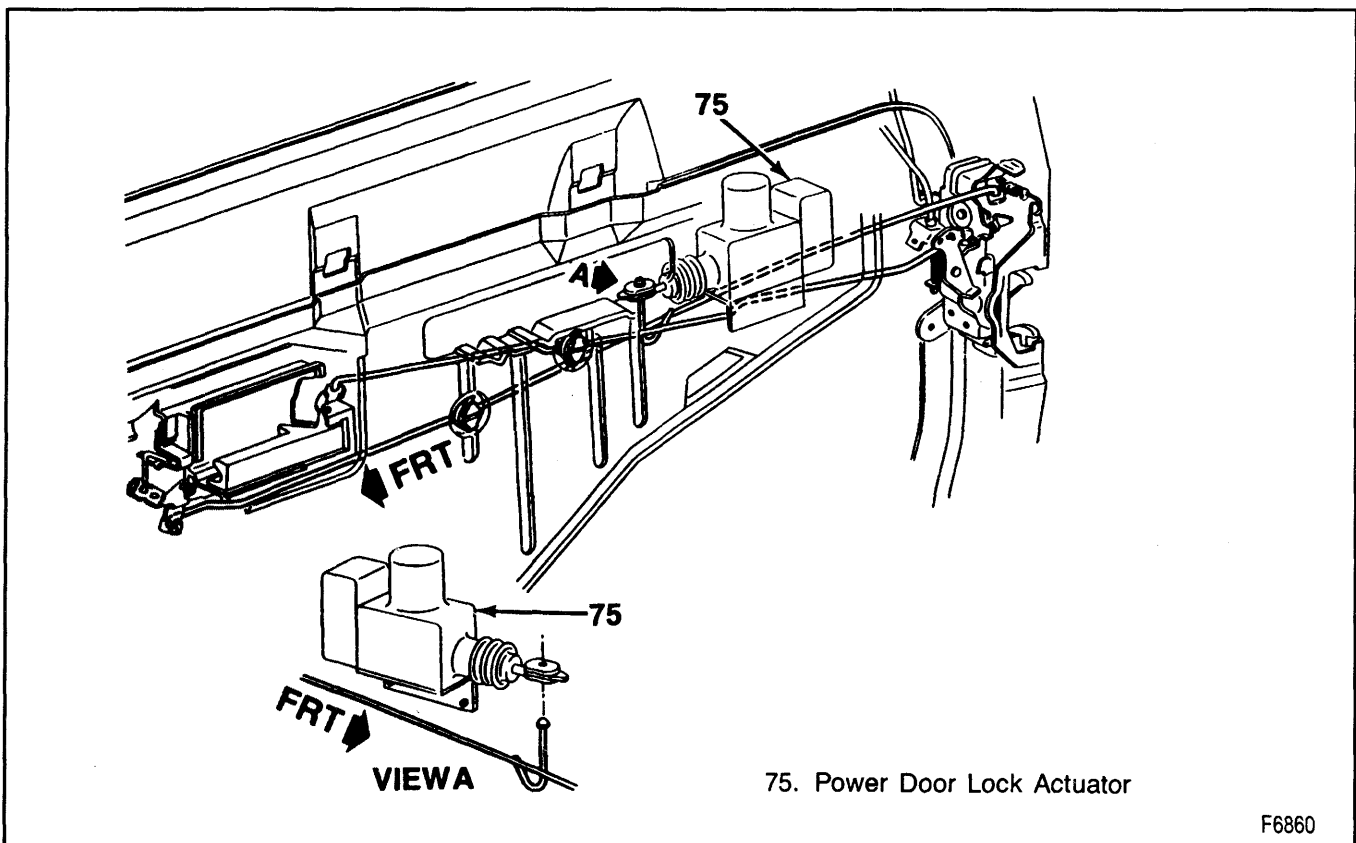


Figure 17—Power Door Lock Actuator

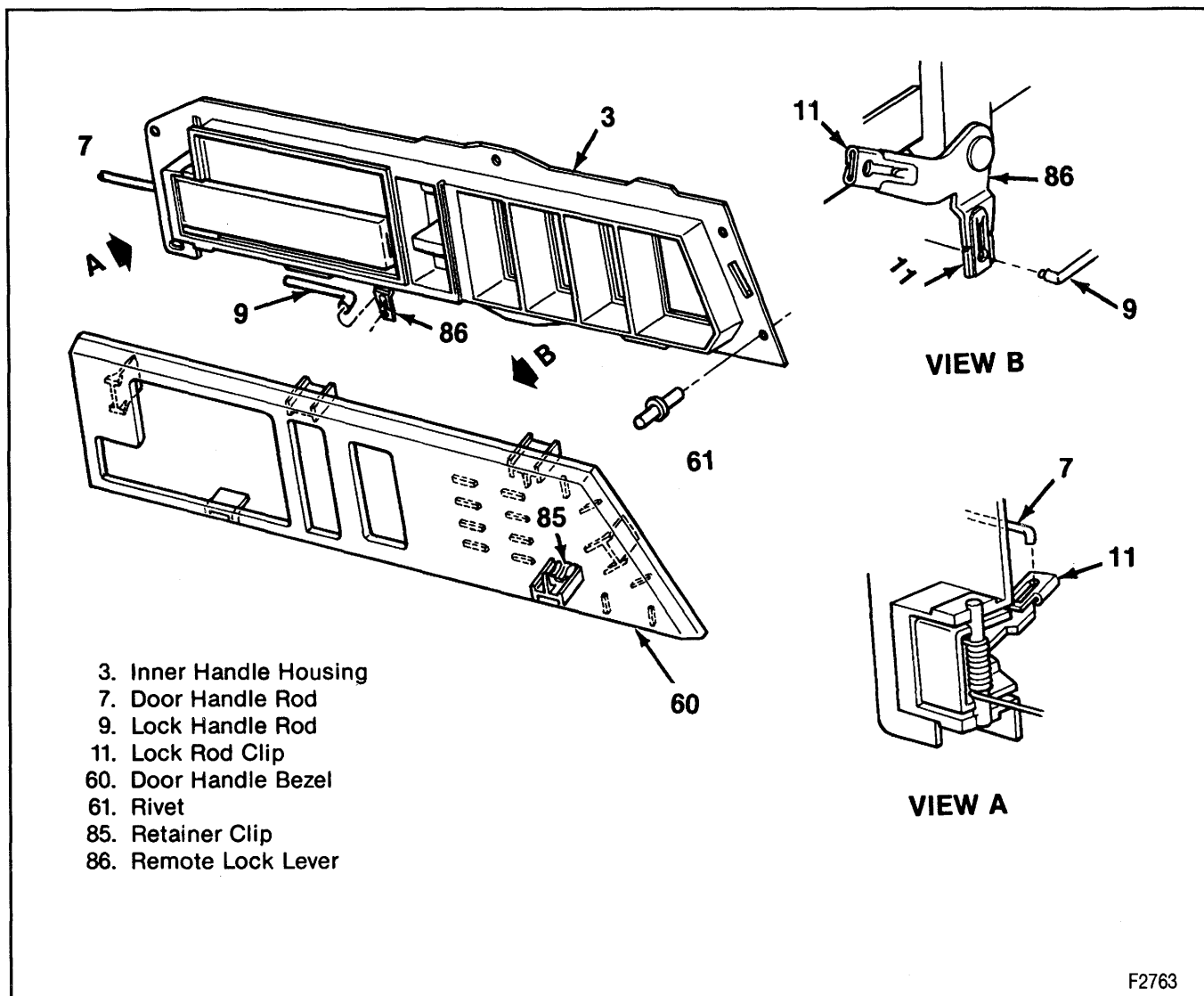


Figure 18—Inner Door Handle Components

INNER DOOR HANDLE HOUSING REPLACEMENT

↔ Remove or Disconnect (Figure 18)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Inner handle housing rivets.
3. Inner handle housing.
4. Control rods from the handle and the lock. Refer to "Door Lock Rod Replacement."
5. Switch harness (if used).

↔ Install or Connect (Figure 18)

1. Switch harness (if used).
2. Control rods to the handle and the lock. Refer to "Door Lock Rod Replacement."
3. Inner handle housing.
4. Inner handle housing rivets.
5. Door trim panel. Refer to "Door Trim Panel Replacement."

BINDING LOCK CYLINDERS

Binding or sticking door lock cylinders and keys that are hard to insert or remove may be corrected in many cases by applying the proper lubrication.

The recommended materials for lubricating these components are (in order of preference):

- Lubricant GM P/N 12345120 (or equivalent).
- 5 W 30 motor oil.
- Silicone spray GM P/N 1052276 (or equivalent)

Penetrating lubricants (such as GM P/N 1052949 and WD-40®) ARE NOT recommended because they wash out the original lubrication and eventually evaporate, leaving little or no lubricating material. However, if these materials are used to unfreeze or loosen lock cylinder components, refer to steps 2 through 4 below for proper methods of lubrication.

Frozen lock cylinders due to cold weather may be repaired using the following procedure:

1. Apply heat to cylinder with a heat gun while being careful not to damage the painted surfaces.

10A1-22 DOORS

2. Hold the door shutter open with a paper clip (or similar item) and force air into cylinders using compressed air and a blow gun attachment.
3. While holding the shutter door open, inject a small amount of lubricant (refer to above recommendations) into cylinder.
4. Work the key into the cylinder several times and wipe any excess lubrication residue from key.

DOOR LOCK CYLINDER AND OUTSIDE HANDLE REPLACEMENT

New lock cylinders are available as replacement parts. If door lock cylinders require replacement for any reason, apply a coating of GM P/N 12345120 or equivalent lubricant inside of the lock case and cylinder key-way prior to assembling and installing the cylinder.

To repair a binding lock cylinder, refer to "Binding Lock Cylinders." To code a new lock cylinder, refer to "Lock Cylinder Coding" in SECTION 0A.

↔ Remove or Disconnect (Figures 19 and 20)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Door module and window. Refer to "Door Module Replacement."
3. Outside handle rod from the rod clip.
4. Lock cylinder rod from the rod clip.
5. Outside handle mounting screws.
6. Door lock cylinder from the outside handle housing.
7. Handle.

↔ Install or Connect (Figures 19 and 20)

1. Handle to the vehicle.
2. Door lock cylinder to the outside handle housing.
3. Lock cylinder rod to the lock cylinder clip.
4. Handle rod to the handle assembly clip.

NOTICE: Refer to "Notice" on page 10A1-1.

5. Outside handle mounting screws.

⊞ Tighten

- Screws to 4 N·m (35 lbs. in.).
6. Door module and glass.
 7. Door trim panel. Refer to "Door Trim Panel Replacement."

DOOR LOCK ROD REPLACEMENT

Rods are used to connect the door actuating levers with the inside and outside handles and the inside lock knob.

↔ Remove or Disconnect (Figure 21)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Screws from the door module.

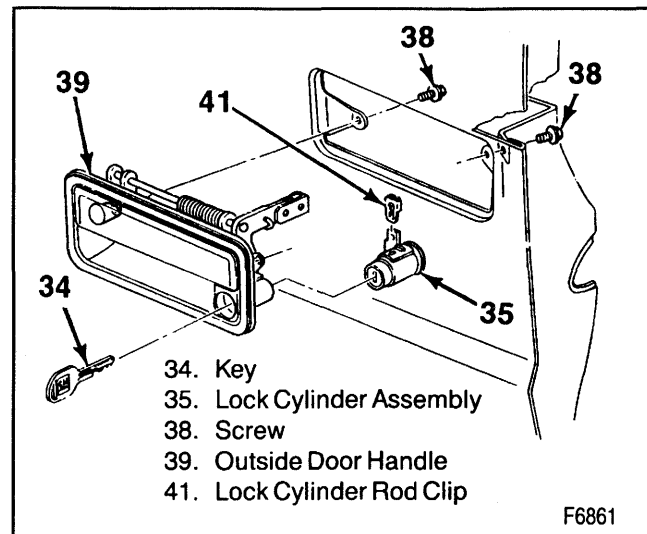
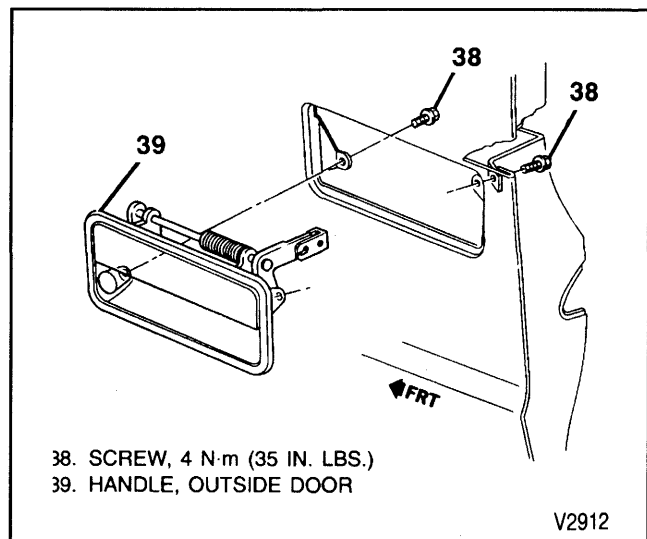


Figure 19—Front Door Lock Cylinder and Outside Handle

- Rotate the door module inboard for access to rods and clips.
3. Spring clip.
 - A. Insert an awl into the indentation on the lever.
 - B. Slide the clip forward far enough to disengage the rod from the lever.
 4. Rod from the lever.

↔ Install or Connect (Figure 21)

1. Rod through the spring clip.
2. Rod and spring clip to the lever.
 - Slide the clip over the rod and engage the tang into the indentation on the lever.
3. Door module to door panel screws.
4. Water deflector. Refer to "Inner Door Water Deflector Replacement."
5. Door trim panel. Refer to "Door Trim Panel Replacement."



38. SCREW, 4 N·m (35 IN. LBS.)
39. HANDLE, OUTSIDE DOOR

V2912

Figure 20—Side Rear Door Outside Handle

WINDOW REGULATOR AND MOTOR REPLACEMENT

The power window motor is not serviced. It is replaced as a unit with the regulator.

↔ Remove or Disconnect (Figures 22 and 23)

1. Negative battery cable (with power door components). Refer to SECTION 0A.
2. Door trim panel. Refer to "Door Trim Panel Replacement."
3. Water deflector. Refer to "Inner Door Water Deflector Replacement."
4. Door lock linkage.
5. Door module and glass. Refer to "Door Module Replacement."
6. Window.
 - Slide window glass channel from the regulator roller assembly.
7. Regulator assembly rivets.
8. Regulator and motor as a unit.

↔ Install or Connect (Figures 22 and 23)

1. Regulator and motor assembly to the module panel.
2. Window.
 - Slide window glass channel into the regulator roller assembly.
3. Window and module to the door.

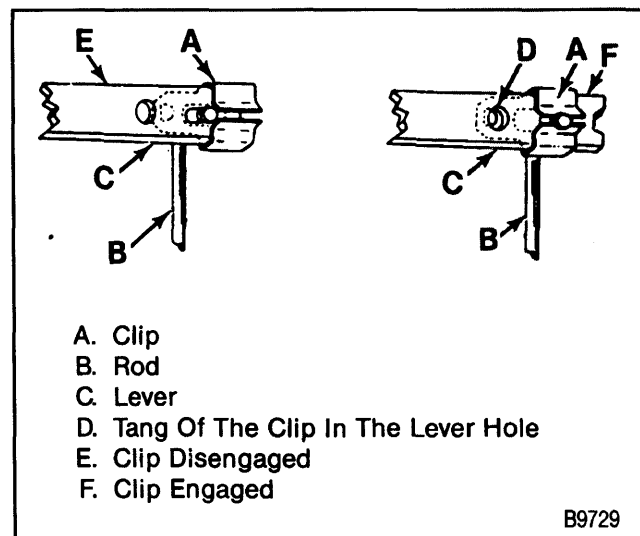


Figure 21—Door Clips

4. Lock rods to the retainer clips.
5. Module panel screws, starting with the top front and top rear screws.
6. Door lock linkage.
7. New water deflectors. Refer to "Door Inner Panel Water Deflector Replacement."
8. Door trim panel. Refer to "Door Trim Panel Replacement."
9. Negative battery cable (power components only).

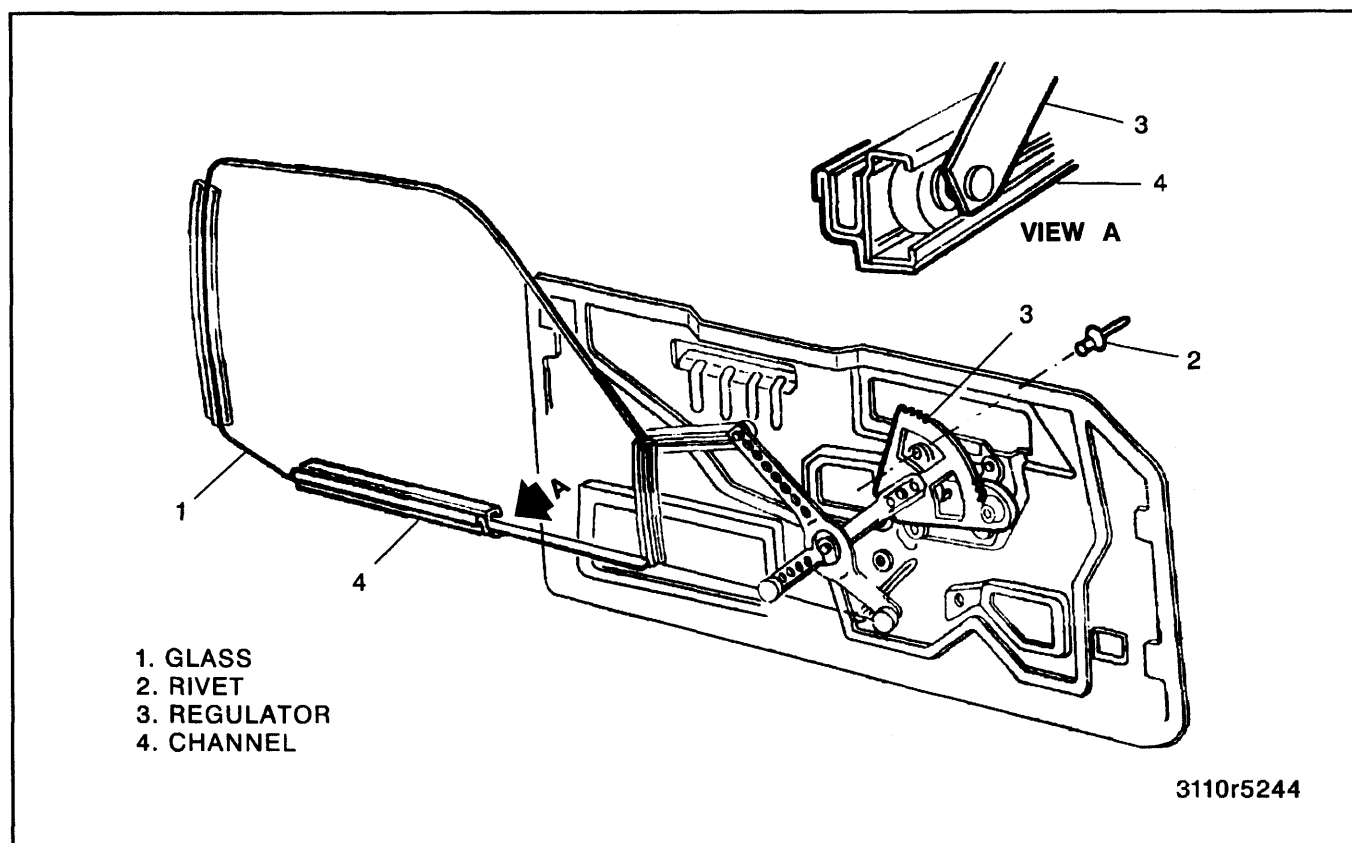


Figure 22—Window Regulator

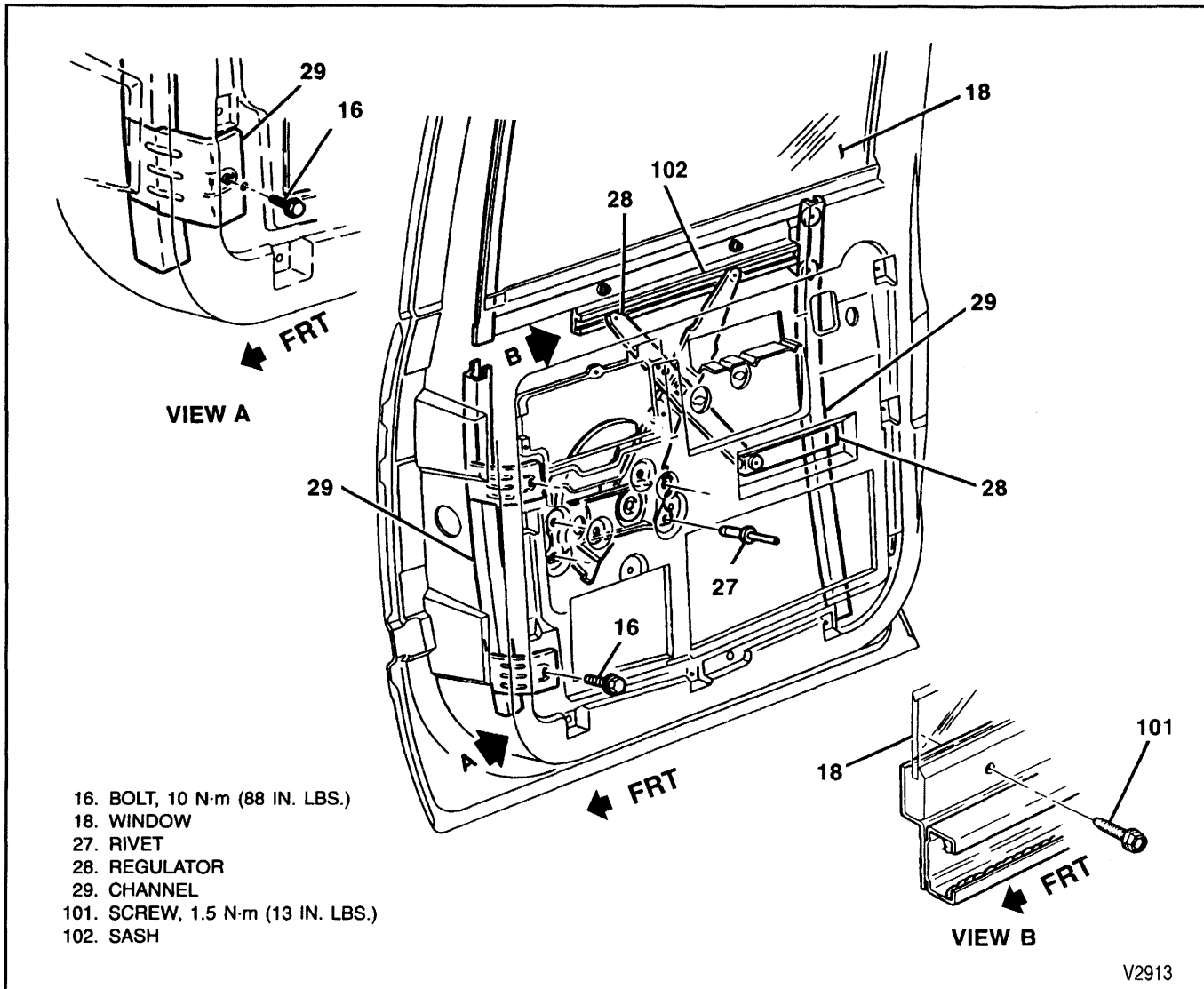


Figure 23—Rear Door Window Regulator

WINDOW REPLACEMENT

↔ Install or Connect (Figures 22, 23, and 24)

↔ Remove or Disconnect (Figures 22, 23, and 24)

CAUTION: Always wear heavy gloves when handling glass to avoid the risk of personal injury.

CAUTION: Always wear heavy gloves when handling glass to avoid the risk of personal injury.

NOTICE: For steps 3, and 7, refer to "Notice" on page 10A1-1.

- Roll the window all the way down.

1. Window regulator handle. Refer to "Window Regulator Handle Replacement."
2. Door trim panel. Refer to "Door Trim Panel Replacement."
3. Door module panel. Refer to "Door Module Replacement."
4. Slide glass from the channel (figures 22 and 23).

1. Glass into the channel.
2. Door module and glass assembly into the bottom of the door.
 - A. First fit the glass into the rear channel in the door.
 - B. Fit the glass into the front run channel while pulling the channel toward the glass.
3. Upper front run channel bolt.
 - Do not tighten.
4. Lock rods to door module.
5. Boot over the wiring harness from the door to the body.
6. Wiring to the connector inside the door hinge pillar.

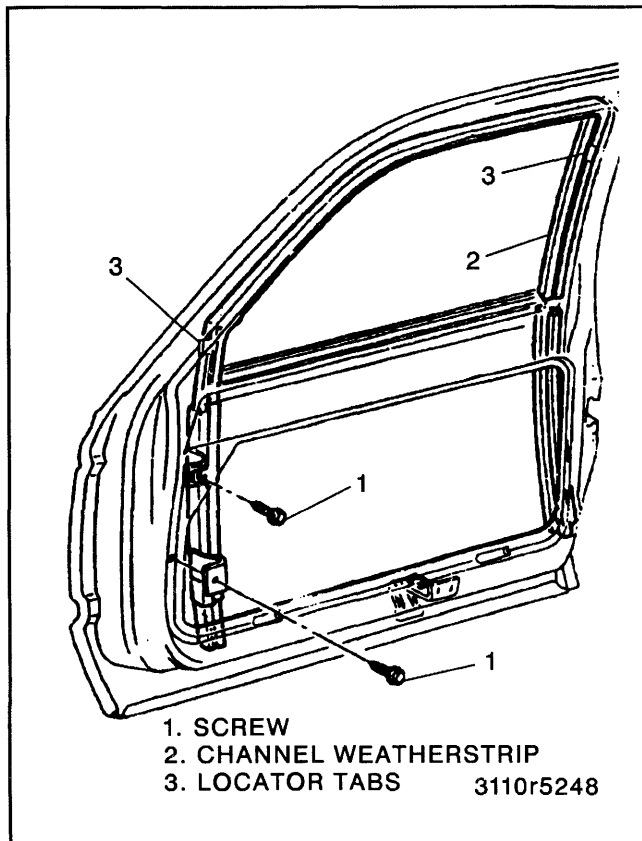


Figure 24—Window Run Channel

7. Lower front run channel bolt.
 - Do not tighten.
8. Lock rods to the module.
9. New water deflector. Refer to "Door Inner Panel Water Deflector Replacement."

NOTICE: Refer to "Notice" on page 10A1-1.

10. Door module to door screws, starting with the top front and top rear screws.



Tighten

- Tighten the upper and lower front run channel screws to 10 N·m (88 lbs. in.).
11. Door trim panel. Refer to "Door Trim Panel Replacement."

WINDOW RUN CHANNEL WEATHERSTRIP REPLACEMENT



Remove or Disconnect

- Roll down the window.
1. Front and rear locator tabs.
 2. Window run channel weatherstrip by pulling weatherstrip from front or rear channel runs.



Install or Connect

1. Window run channel weatherstrip by sliding between run channel and glass.

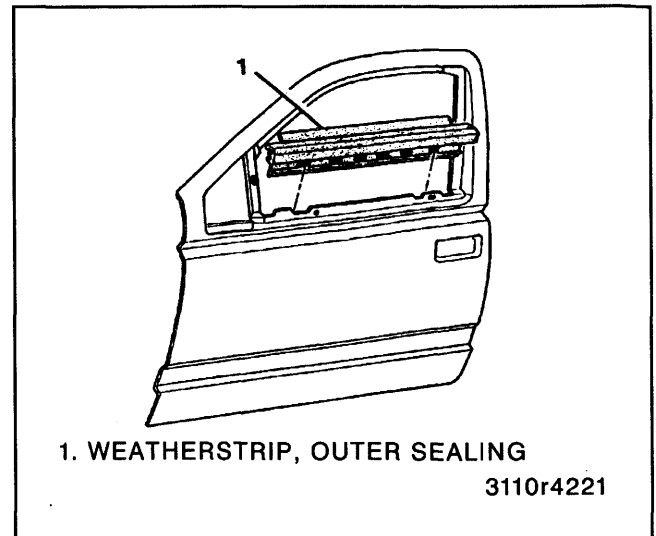


Figure 25—Outer Belt Seal Weatherstrip

WINDOW RUN CHANNEL REPLACEMENT



Remove or Disconnect (Figure 24)

- Roll up the window.
1. Door trim panel. Refer to "Door Trim Panel Replacement."
 2. Door to window run channel bolts.
 - Pull back water deflector.
 3. Run channel from the door.



Install or Connect (Figure 24)

1. Window run channel to the door.

NOTICE: Refer to "Notice" on page 10A1-1.

2. Door to window run channel screws.



Tighten

- Screws to 10 N·m (88 lbs. in.).
3. Reseal water deflector.
 4. Door trim panel. Refer to "Door Trim Panel Replacement."

OUTER BELT SEAL REPLACEMENT



Remove or Disconnect (Figure 25 or 26)

- Outer sealing strip from the door by pulling center of seal from door.



Install or Connect (Figure 25 of 26)

- Outer sealing strip to the door by inserting rear slot of seal to door frame. Insert front slot of seal to door. Snap seal down over flange.

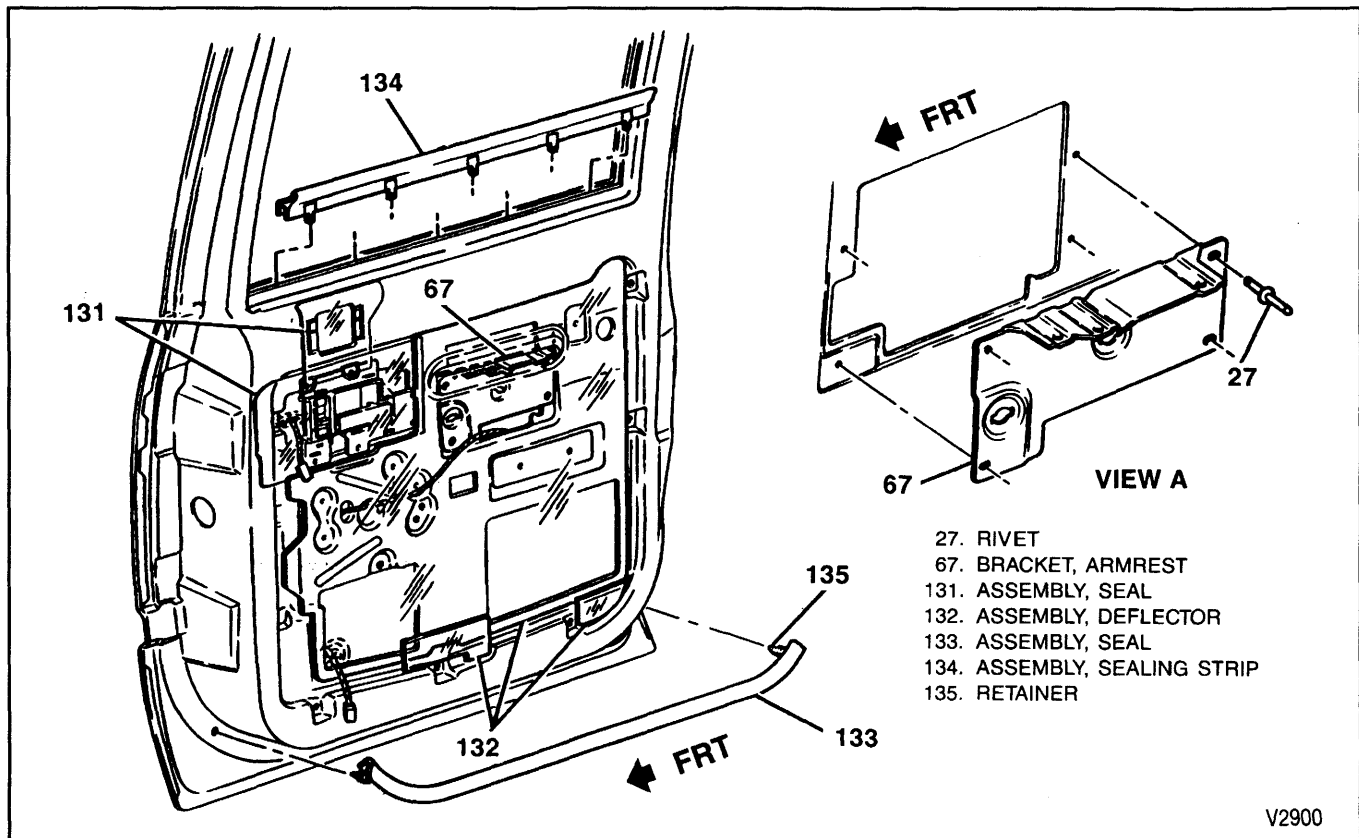


Figure 26—Rear Side Door Outer Belt Window Seal and Lower Door Seal Assembly

LOWER DOOR SEAL ASSEMBLY REPLACEMENT

↔ Remove or Disconnect (Figure 26)

1. Remove fasteners.
2. Remove lower door seal.

→→ Install or Connect (Figure 26)

1. Position lower door seal to door.

NOTICE: Refer to "Notice" on page 10A1-1.

2. Snap fasteners in place.

OUTSIDE MIRROR REPLACEMENT

↔ Remove or Disconnect (Figure 27)

1. Door trim panel. Refer to "Door Trim Panel Replacement."
2. Nuts holding the mirror to the door.
3. Mirror from the door.

→→ Install or Connect (Figure 27)

1. Mirror to the door.

NOTICE: Refer to "Notice" on page 10A1-1.

2. Nuts holding the mirror to the door.



Tighten

- Nuts to 10 N.m (88 lbs. in.).

3. Door trim panel. Refer to "Door Trim Panel Replacement."

PRIMARY WEATHERSTRIP REPLACEMENT

The primary weatherstrip is installed at the pinchweld flanges that form at the door openings. The weatherstrip is attached by friction to the pinchweld.



Remove or Disconnect (Figures 28 and 29)

- Primary weatherstrip from the door by pulling it from the door pinchweld flange.



Install or Connect (Figures 28 and 29)

1. Door weatherstrip to the door pinchweld flange.
 - A. Position the weatherstrip in the upper rear corner of the door opening so that the part end will be 6 inches below the rocker before installation.
 - B. Push the weatherstrip onto the flange, while compressing weatherstrip into each corner, then butt joint of ends of the weatherstrip to approximately 6 inches forward of the lower rear corner of the door opening.

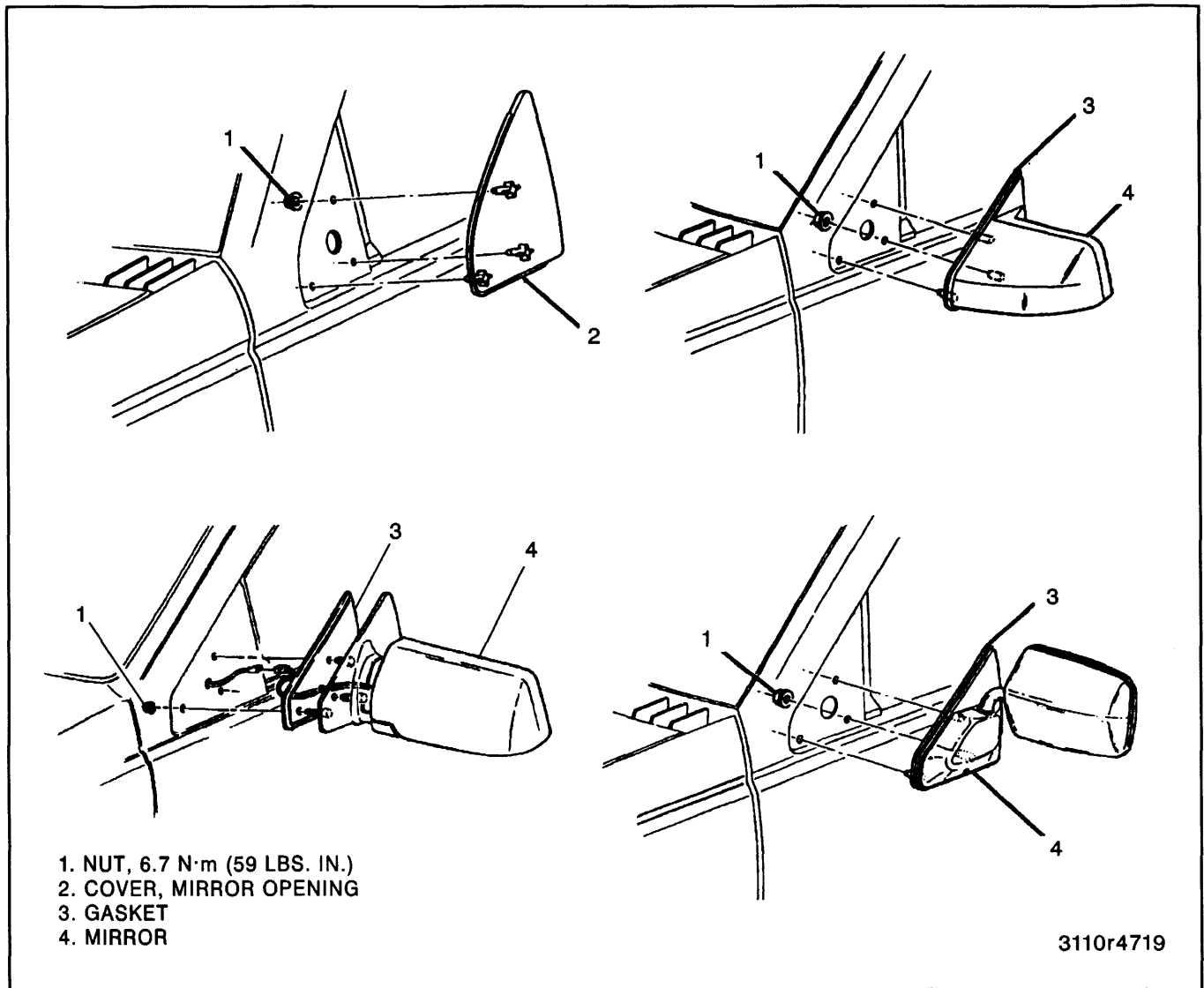


Figure 27—Outside Rear View Mirror

ON-VEHICLE SERVICE OF CARGO DOORS

CARGO DOOR REPLACEMENT

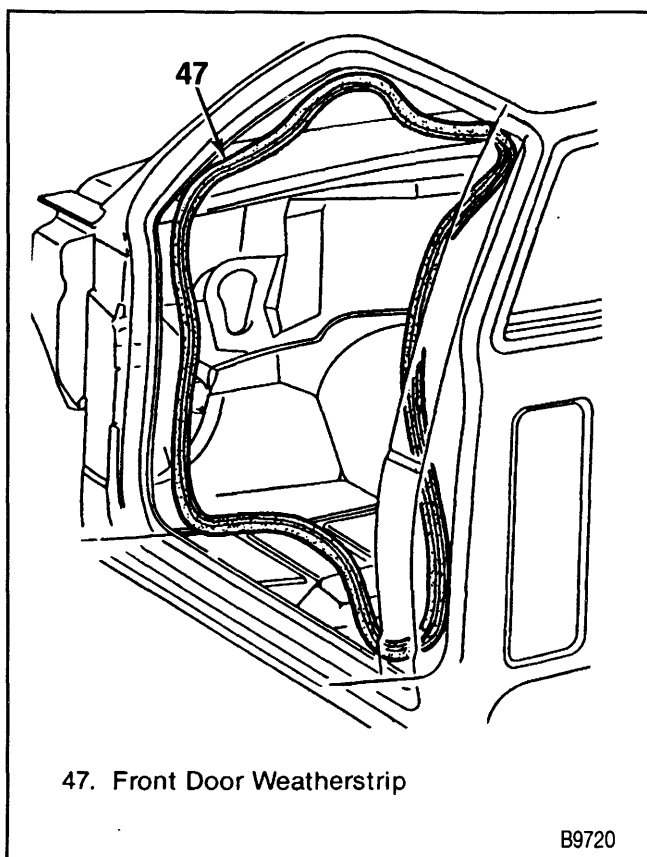
↔ Remove or Disconnect (Figure 30)

1. Negative battery cable (vehicles with power components only). Refer to SECTION 0A.
2. Harness connectors. (Vehicles with power components only).
 - Apply cloth backed tape to the door, and body pillar.
3. Lower hinge pin using a soft-faced hammer and locking pliers.
 - Temporarily install a bolt through the lower hinges to hold the door in place while removing the upper hinge pin.

4. Upper hinge pin.
5. Bolt in lower hinge pin hole.
6. Door from vehicle.

→→ Install or Connect (Figure 30)

1. Door to the vehicle.
2. Bolt through the lower hinge pin holes.
3. Upper hinge pin with the pointed end down using a soft-faced hammer and a pair of locking pliers to grasp the pin.
 - Remove the temporary bolt in the lower hinge.
4. Lower hinge pin with the pointed end down.
5. Wiring harness connectors (if used).
 - Remove cloth backed tape to the door, and the body pillar.
6. Negative battery cable.



47. Front Door Weatherstrip

B9720

Figure 28—Front Door Opening Weatherstrip

CARGO DOOR HINGE CHECK ASSEMBLY

Remove or Disconnect (Figure 31)

1. Apply cloth backed tape to the door and body pillar.
2. Pin retainer.
3. Hinge pin using a soft-faced hammer and locking pliers.
4. Spring.
5. Check assembly.

Install or Connect (Figure 31)

1. Check assembly.
 2. Spring.
 3. Hinge pin using a soft-faced hammer and locking pliers.
 4. New pin retainer.
- Remove cloth backed tape from the door and the body pillar.

CARGO REAR DOOR STRIKERS

Remove or Disconnect (Figure 32)

1. Mark the position of the upper and/or lower striker.
2. Striker screw.
3. Striker.

Install or Connect (Figure 32)

1. Striker to the vehicle.

NOTICE: Refer to "Notice" on page 10A1-1.

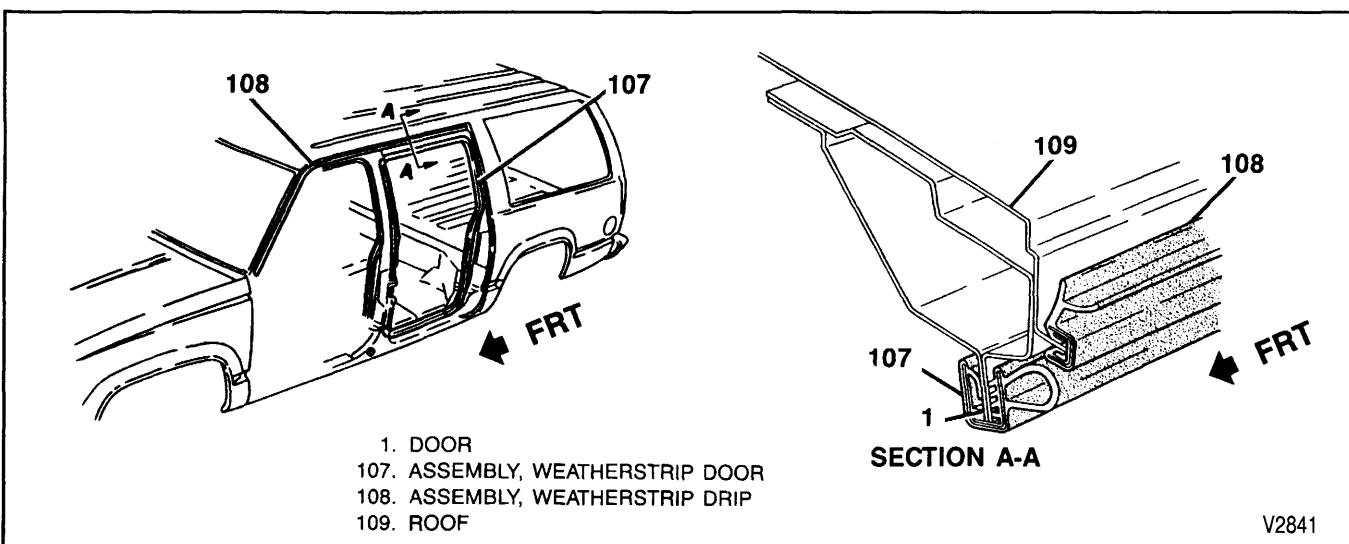
2. Striker screw.
3. Align the striker and screw with the previously made mark.

Tighten

- Screw to 7.5 N.m (66 lbs. in.).

DOOR LOCK CYLINDER, ROD, AND OUTSIDE HANDLE REPLACEMENT

New lock cylinders are available as replacement parts. If door lock cylinders require replacement for any reason, apply a coating of GM P/N 12345120 lubricant or equivalent inside of the lock case and cylinder key-way prior to assembling and installing the cylinder.



1. DOOR
107. ASSEMBLY, WEATHERSTRIP DOOR
108. ASSEMBLY, WEATHERSTRIP DRIP
109. ROOF

SECTION A-A

V2841

Figure 29—Side Door Opening Weatherstrip

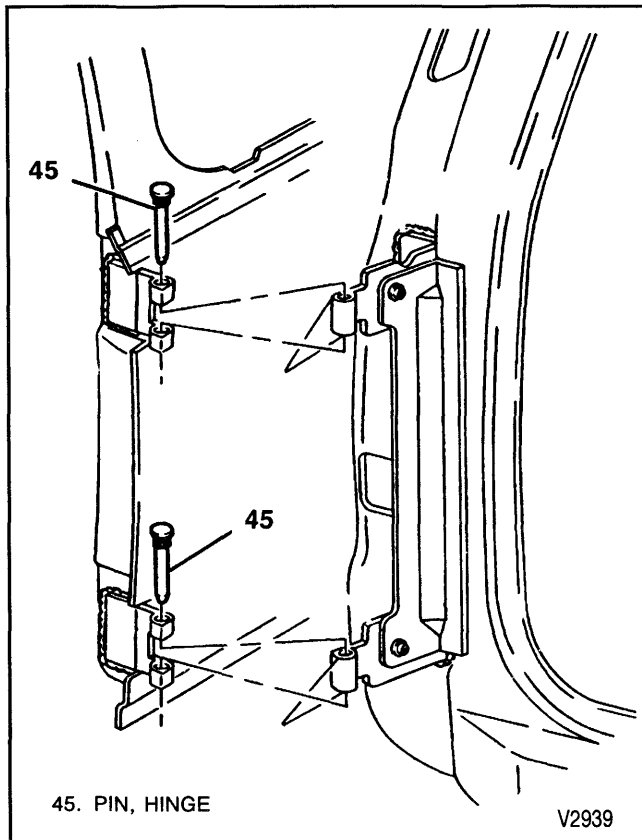


Figure 30—Rear Door Hinge Pin

To repair a binding lock cylinder, refer to "Binding lock cylinders." To code a new lock cylinder, refer to "Lock Cylinder coding" in SECTION 0A.

Remove or Disconnect (Figures 34 through 37)

1. Door trim panel. Refer to "Door Trim Panel Replacement" in this section.
2. Door module and window. Refer to "Door Module Replacement."

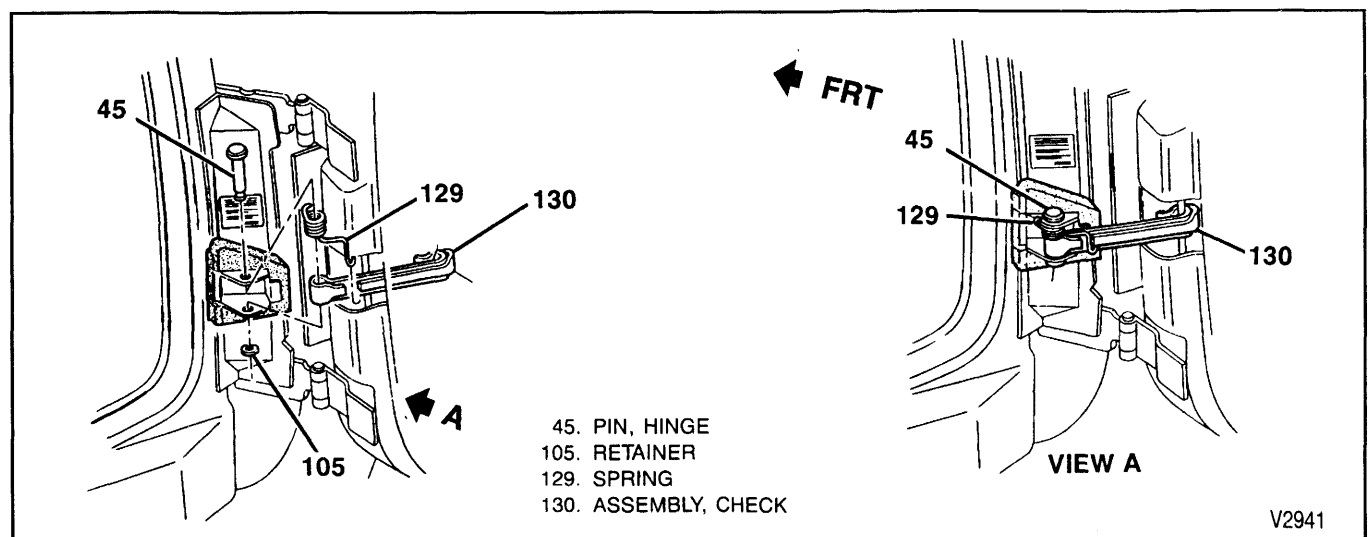


Figure 31—Hinge Check Assembly

3. Outside handle rod from the rod clip.
4. Lock cylinder rod from the rod clip.
5. Outside handle mounting screws.
6. Door lock cylinder from the outside handle housing.
7. Handle.

Install or Connect (Figures 34 through 37)

1. Handle.
2. Door lock cylinder to the outside handle housing.
3. Lock cylinder rod to the lock cylinder clip.
4. Handle rod to the handle assembly clip.

NOTICE: Refer to "Notice" on page 10A1-1.

5. Outside handle mounting screws.

Tighten

- Screws to 4 N·m (35 lbs. in.).
- 6. Door module and glass. Refer to "Door Module Replacement"
- 7. Door trim panel. Refer to "Door Trim Panel Replacement."

10A1-30 DOORS

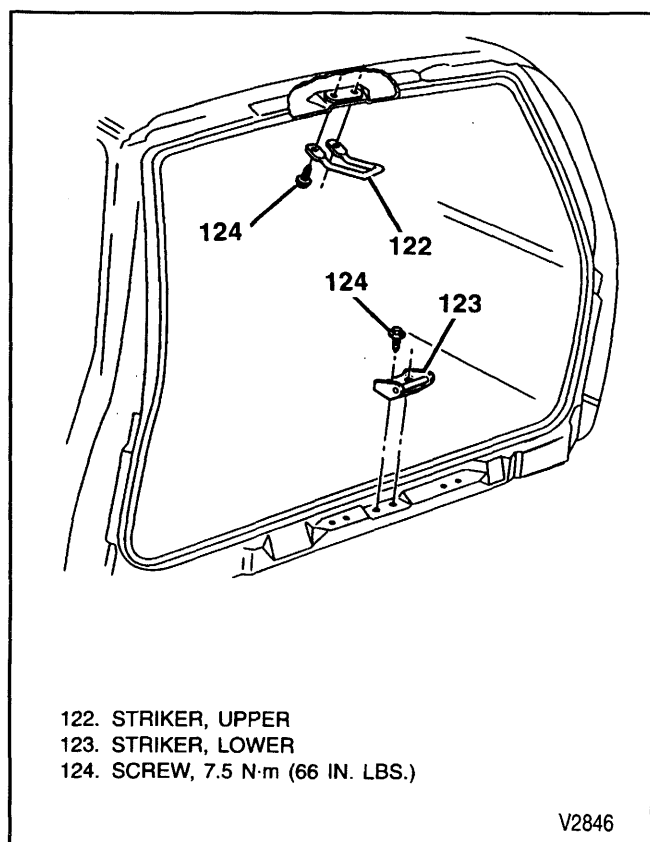
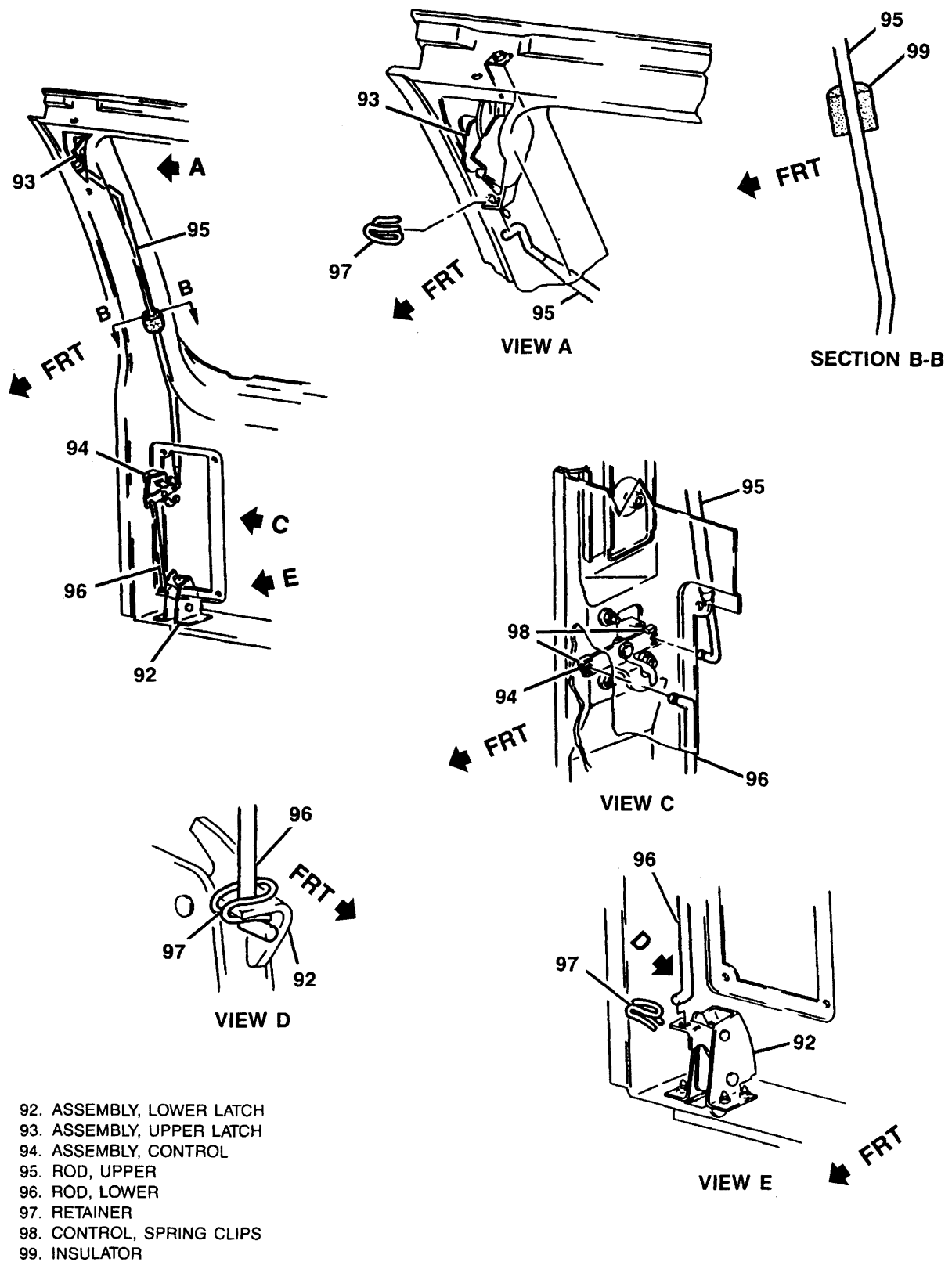


Figure 32—Cargo Upper and Lower Strikers



V2897

Figure 33—Cargo Rear Door Latch

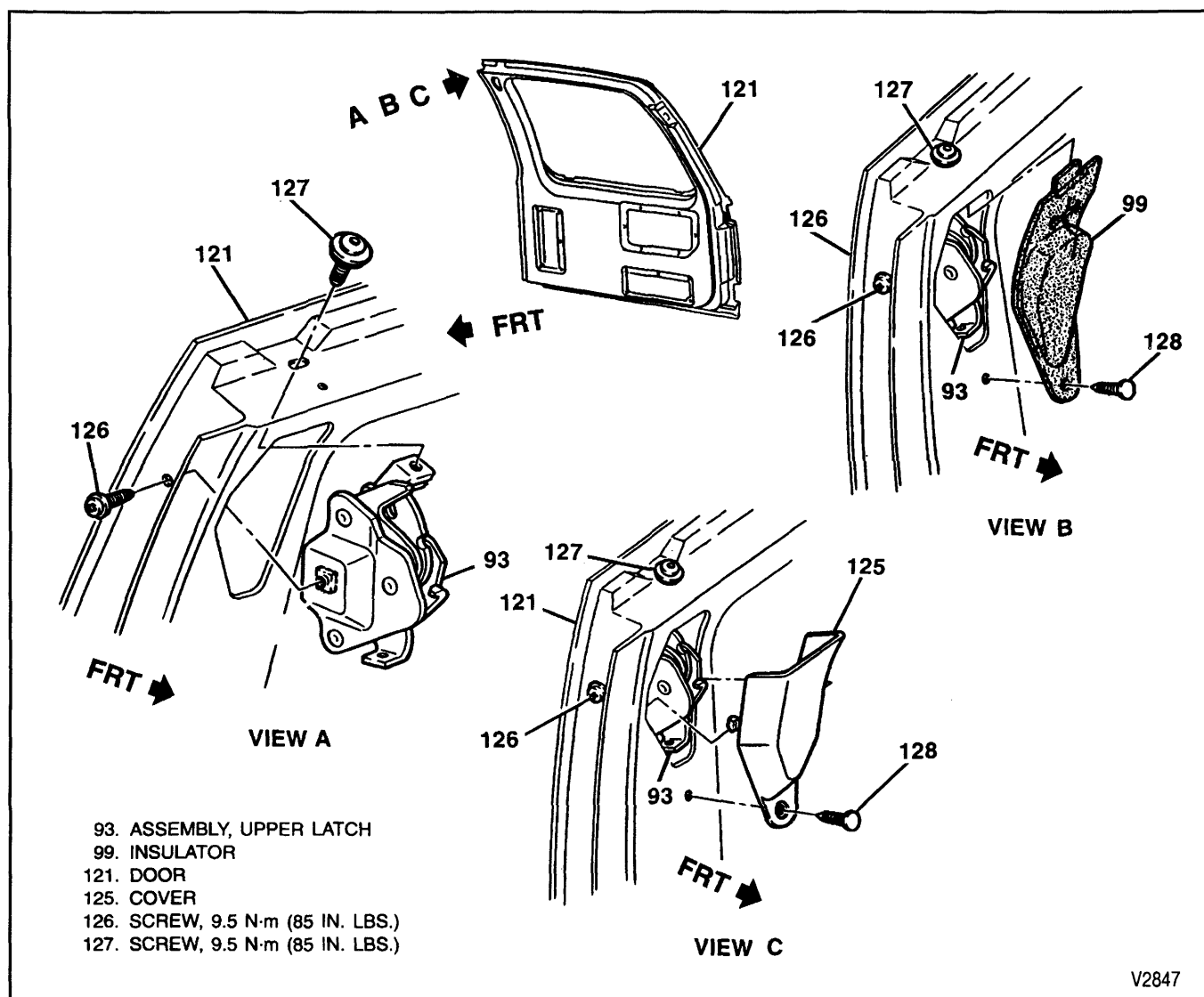


Figure 34—Cargo Upper Latch Assembly

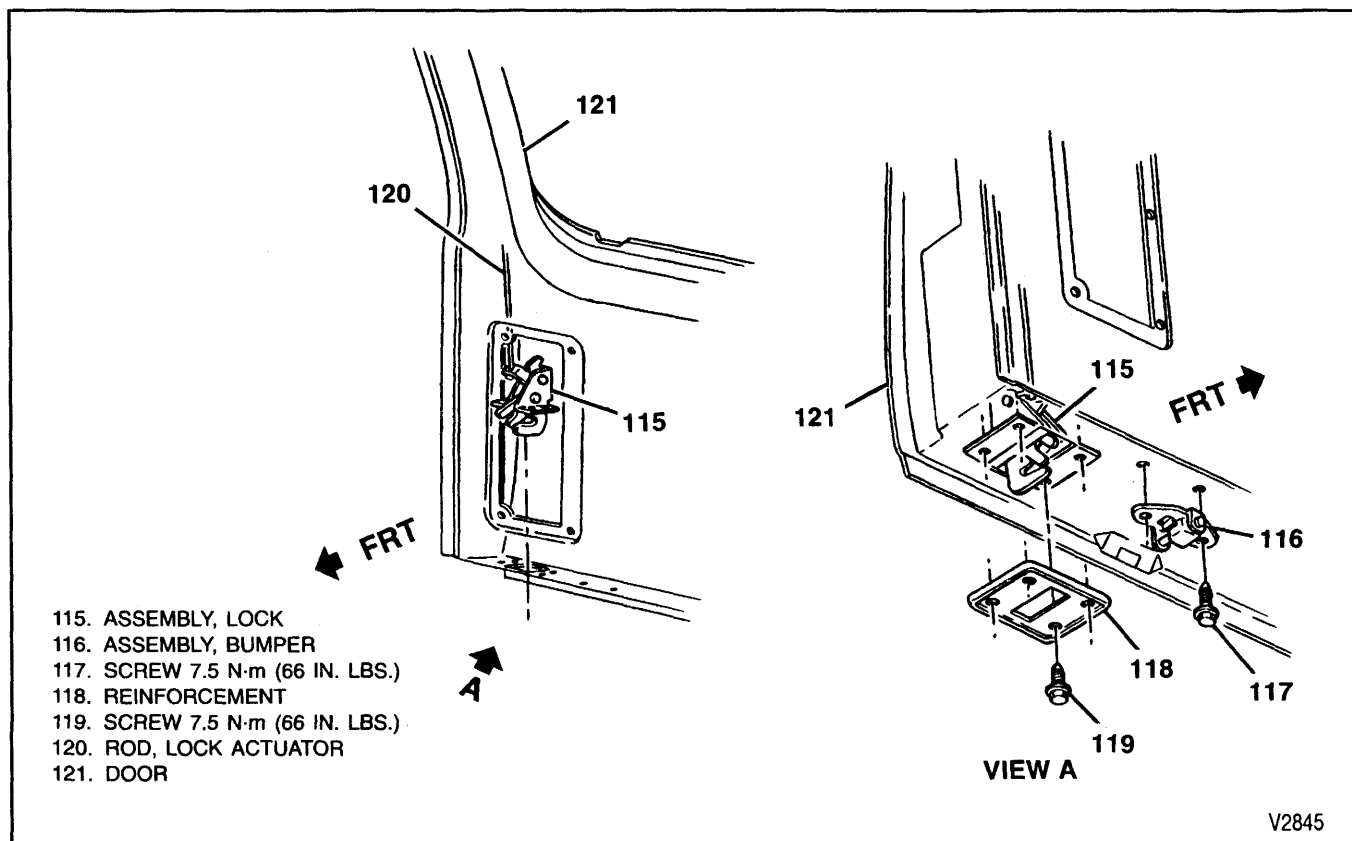


Figure 35—Rear Door Lock

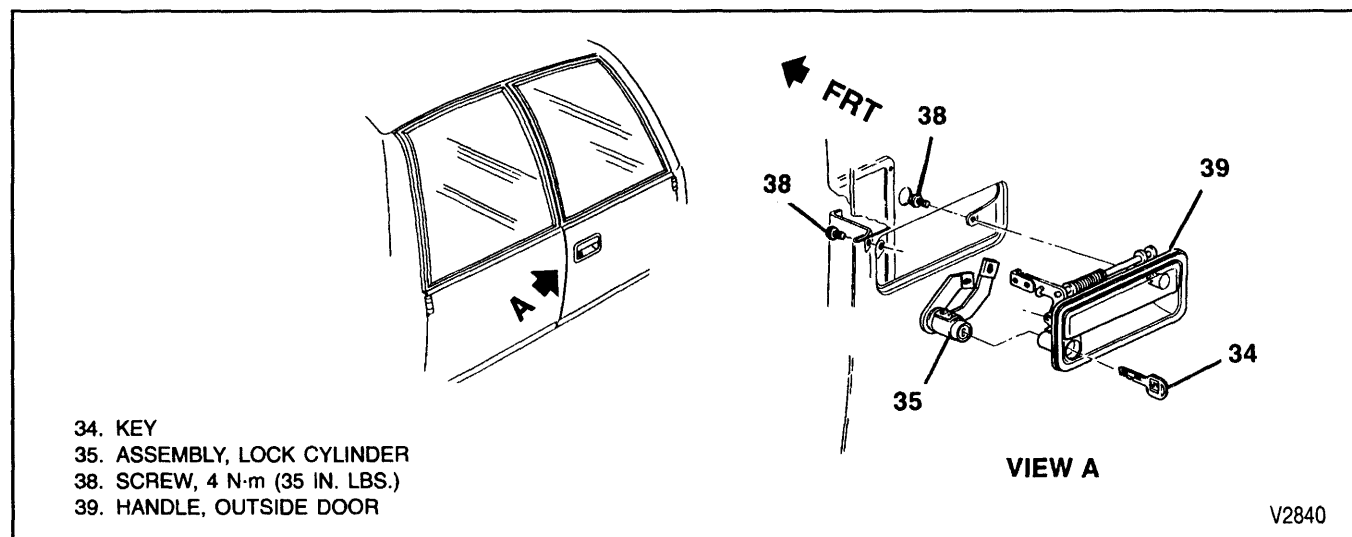


Figure 36—Rear Door Outside Handle and Lock Cylinder

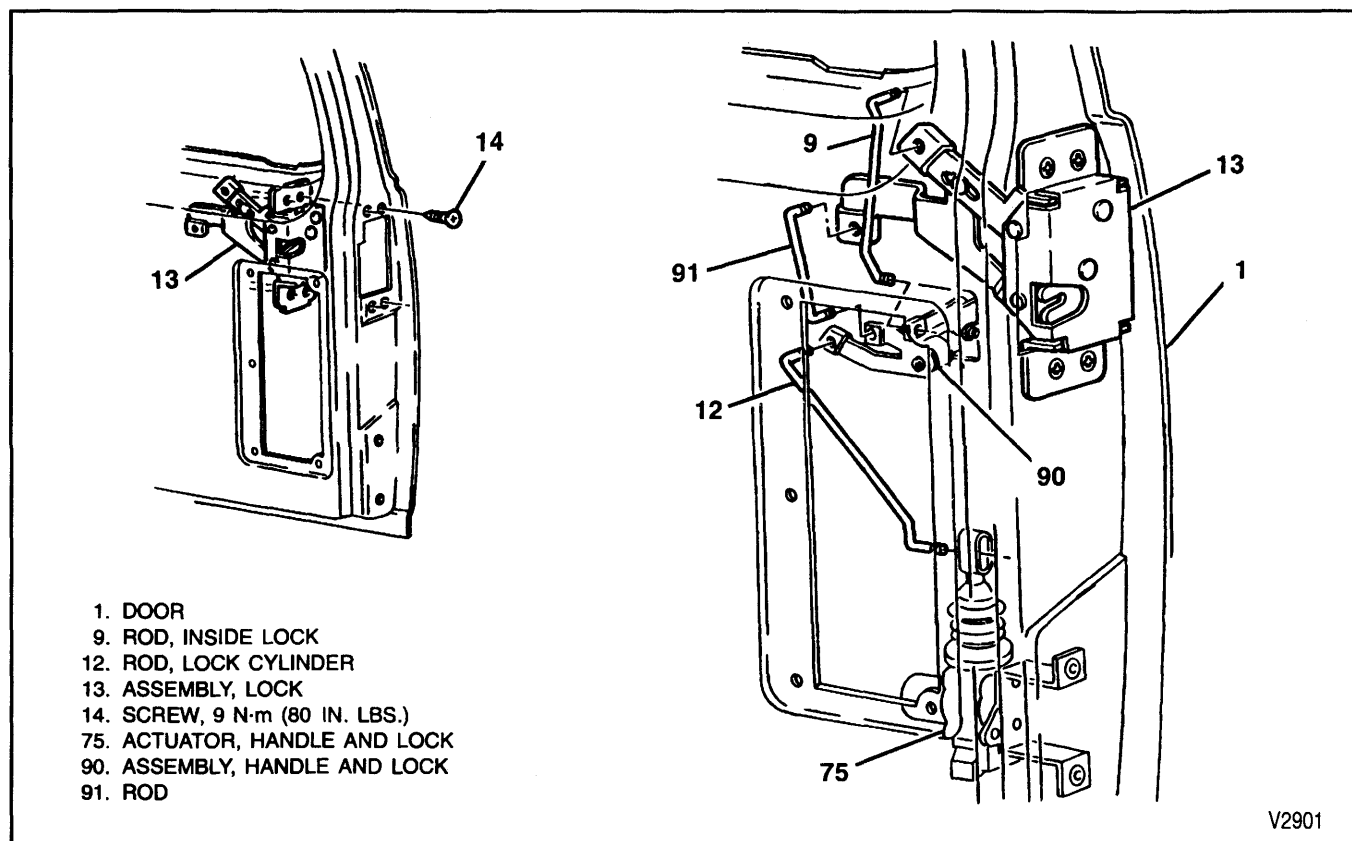


Figure 37—Rear Door Lock

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N-m	Lbs. Ft.	Lbs. In.
Door Lock Screws.....	6.7	—	60
Door Module Mounting Screws	4	—	35
Door to Window Run Channel Screws	10	—	88
Front Door Striker Bolt.....	63	46	—
Front Run Channel Screws	10	—	88
Hinge Nuts (Service Replacement Kit)	35	26	—
Outside Door Handle Mounting Screws.....	4	—	35
Outside Rearview Mirror Mounting Nuts	10	—	88
Pressure Relief Valve Mounting Screws	1.6	—	14
Rear Door Striker Bolt	7.5	—	66

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SPECIAL TOOLS



1. DOOR HINGE SPRING COMPRESSOR
2. T47 BIT SOCKET
3. TRIM PAD REMOVER
4. DOOR HANDLE CLIP REMOVER

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NOTES

SECTION 10A2

SEATS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Special Tools	10A2-22

DIAGNOSIS OF MANUAL SEAT ADJUSTER

PROBLEM	POSSIBLE CAUSE	CORRECTION
Adjuster Will Not Lock	1. Wire assembly too tight. 2. Lock bar spring disconnected or broken. 3. Lock bar sticking or binding.	1. Loosen the wire assembly by moving the hooked end to the forward hole of the lock bar. 2. Connect the spring or install a new spring. 3. Lubricate the lock bar pivot. If the bar is binding, eliminate the cause of binding or replace the adjuster.
Adjuster Will Not Unlock	1. Wire assembly too loose or disconnected. 2. Lock bar sticking or binding.	1. Eliminate the slack in the wire assembly by moving the hooked end to the rearward hole of the lock bar. 2. Lubricate the lock bar pivot. If the bar is binding, eliminate the cause of binding or replace the adjuster.

DIAGNOSIS OF MANUAL SEAT ADJUSTER (cont'd)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Seat Hard To Move Forward Or Rearward	1. Adjusters new, not seated. 2. Adjuster(s) improperly lubricated. 3. Adjuster(s) binding due to bent or damaged channels.	1. Operate the seat to the full forward and full rearward positions several times to work the new tightness out of the channels. 2. Lubricate the adjuster channels with Lubriplate Auto-Lube A or equivalent. 3. Replace the adjuster.
Easy Entry Passenger Seat In Extended Cab Does Not Slide Forward When The Seat Is Tilted Forward	Cable from the seat back to the adjuster is disconnected.	Pull back the covering on the seat back and seat. Make sure the cable is still connected and taut from the seat back through the seat to the adjuster.

D0217

DIAGNOSIS OF SIX-WAY POWER ADJUSTER

CONDITION	POSSIBLE CAUSE	CORRECTION
Horizontal operation of the seat is not smooth. Apparent hard operation.	1. Improper lubrication of the seat adjuster carriages and seat adjuster slides. 2. Transmission assembly is loose or binding.	1. Lubricate carriages and seat adjuster slides with a lithium base grease. 2. Inspect transmission assembly. Tighten mounting screws or replace assembly if necessary.
Horizontal chuck or looseness.	1. Seat adjuster carriages out of alignment or worn.	1. Inspect transmission assembly and replace if necessary.
Adjuster will not operate horizontally.	1. No power to the adjuster assembly. 2. Seat adjuster drive cable damaged. 3. Seat adjuster motor is not working.	1. Refer to Driveability, Emissions, and Electrical Diagnosis Manual for this vehicle. 2. Inspect drive cable and replace if necessary. 3. Inspect adjuster motor assembly and replace if necessary.
One or both adjusters will not operate vertically.	1. No power to the adjuster assembly. 2. Seat adjuster drive cables damaged. 3. Seat adjuster motor is not working.	1. Refer to Driveability, Emissions, and Electrical Diagnosis Manual for this vehicle. 2. Inspect drive cables and replace if necessary. 3. Inspect adjuster motor assembly and replace if necessary.

D0311

ON-VEHICLE SERVICE

FRONT SEAT TRIM COVER REPLACEMENT

 Remove or Disconnect (Figure 1)

1. Screws.
2. Seat trim cover from seat.

 Install or Connect (Figure 1)

1. Trim cover to seat.
2. Screws.

FRONT BUCKET SEAT REPLACEMENT

 Remove or Disconnect (Figures 2 and 3)

1. Seat trim cover. Refer to "Trim Cover Replacement".
2. Seat retaining bolts.
3. Seat from the vehicle.

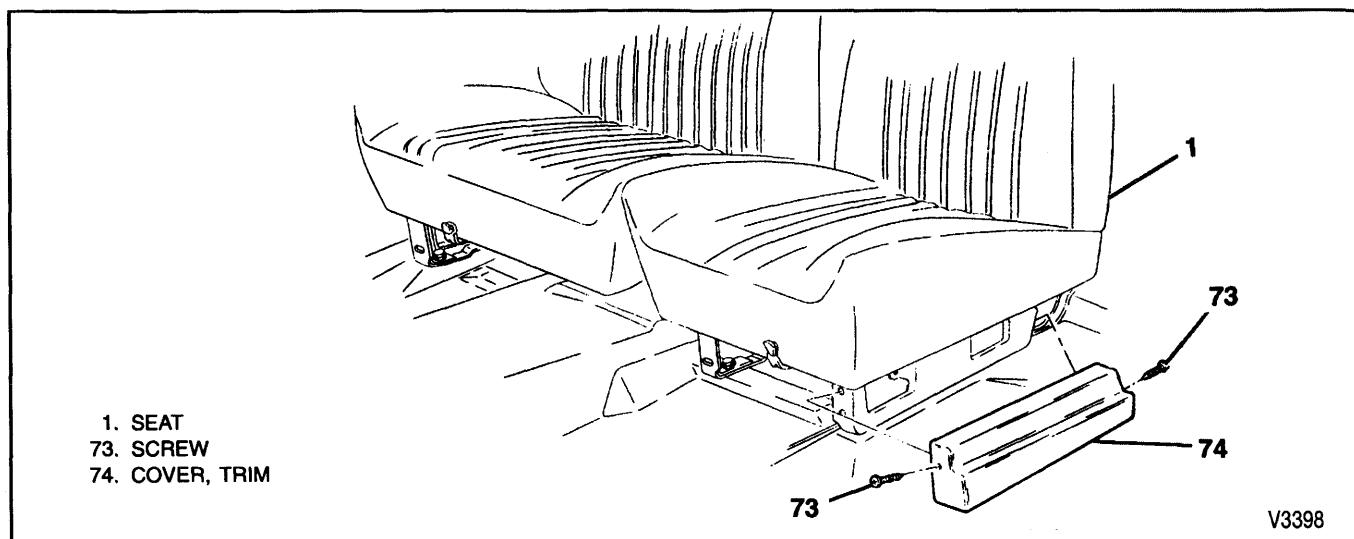


Figure 1—Front Seat Trim Cover

**Install or Connect (Figures 2 and 3)**

1. Seat to the vehicle.

NOTICE: Refer to "Notice" on page 10A2-1.

2. Seat retaining bolts.

**Tighten**

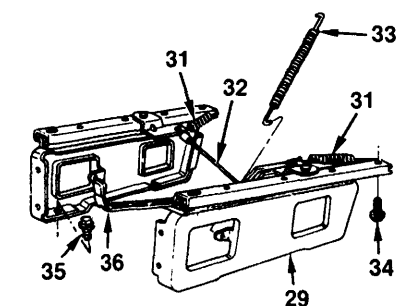
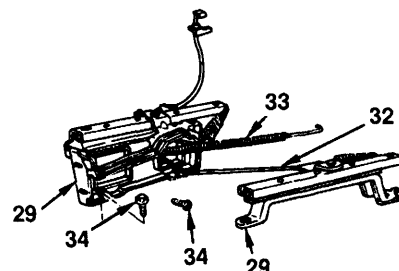
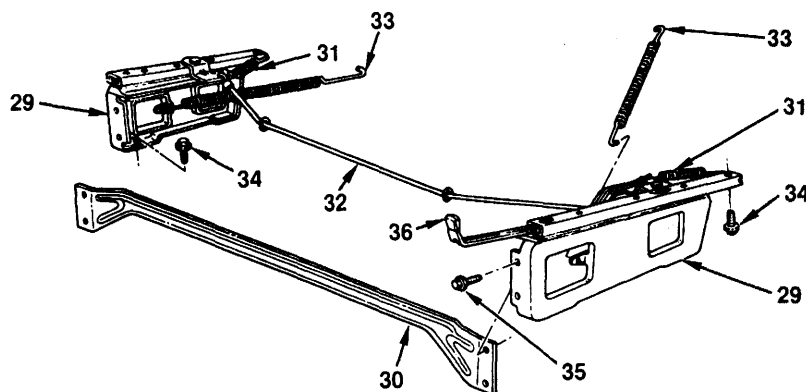
- Bolts to 55 N.m (41 lbs. ft.).

3. Seat trim cover. Refer to "Trim Cover Replacement."

FRONT SPLIT BENCH SEAT REPLACEMENT

**Remove or Disconnect (Figure 4)**

1. Seat trim cover. Refer to "Trim Cover Replacement."
2. Seat retaining bolts.

**BUCKET SEAT ADJUSTER****FRONT SPLIT BENCH SEAT ADJUSTER****BENCH SEAT ADJUSTER**

29. Riser
30. Reinforcement
31. Adjusting Latch Spring
32. Wire Assembly
33. Return Spring
34. Bolt
35. Screw
36. Adjusting Lever

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Figure 2—Manual Seat Adjusters

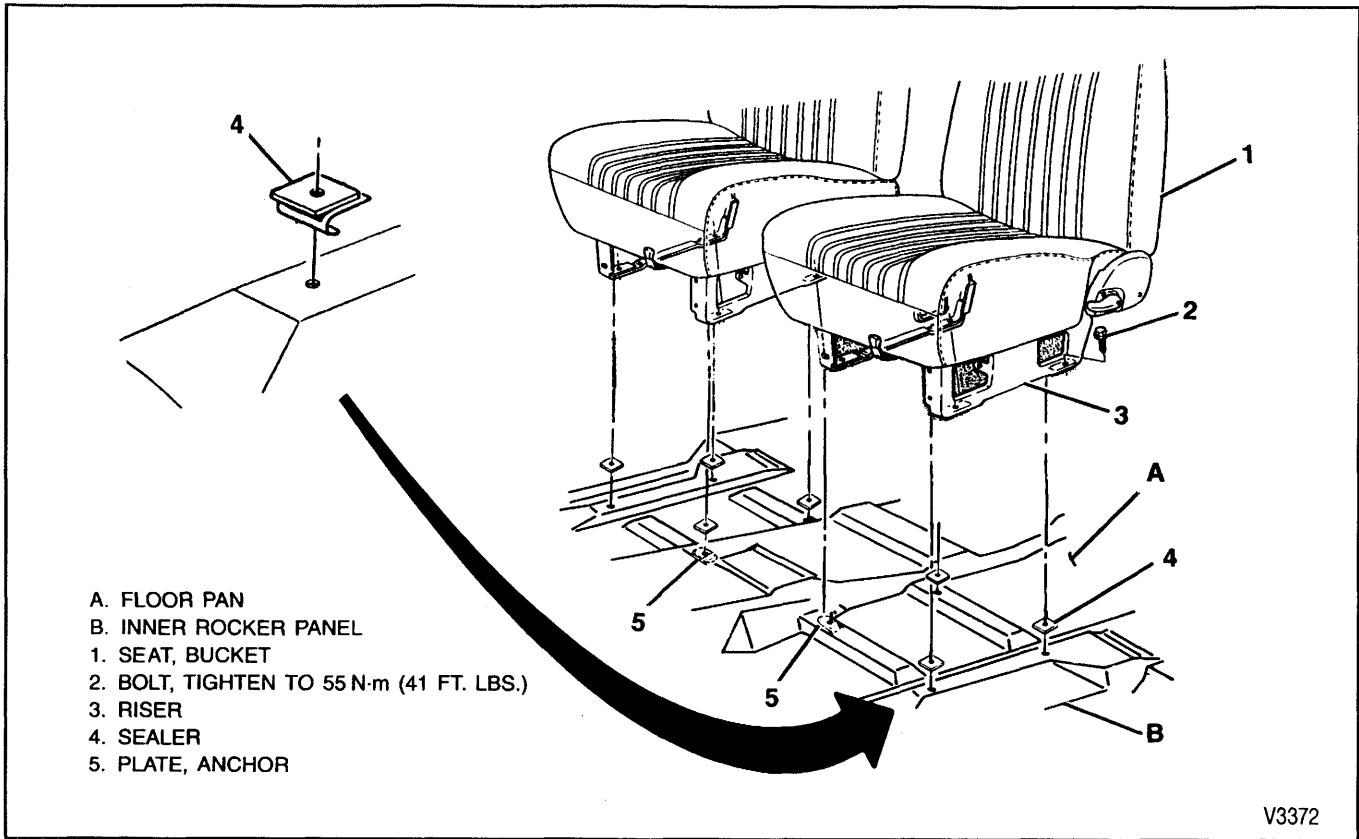


Figure 3—Front Bucket Seat Mounting

3. Seat and seat belt from the vehicle.

→→ Install or Connect (Figure 4)

NOTICE: For steps 2 and 3, refer to "Notice" on page 10A2-1.

1. Seat to the vehicle.
2. Seat retaining bolts.

 **Tighten**

- Bolts to 55 N·m (41 lbs. ft.).

3. Bolt retaining the seat belt to the floor.

 **Tighten**

- Bolt to 55 N·m (40 lbs. ft.).

4. Seat trim cover to seat. Refer to "Trim Cover Replacement."

FRONT BENCH SEAT REPLACEMENT

→→ Remove or Disconnect (Figure 5)

1. Seat trim cover. Refer to "Trim Cover Replacement."
2. Seat retaining bolts.
3. Seat from the vehicle.

→→ Install or Connect (Figure 5)

1. Seat to the vehicle.

NOTICE: Refer to "Notice" on page 10A2-1.

2. Seat retaining bolts.

 **Tighten**

- Bolts to 55 N·m (41 lbs. ft.).

3. Seat trim cover to seat. Refer to "Trim cover replacement".

INTERMEDIATE SEAT REPLACEMENT

→→ Remove or Disconnect (Figures 6 and 7)

1. Front and rear leg trim covers and (figure 8).
2. Seat retaining bolts.
3. Seat from the vehicle.

→→ Install or Connect (Figures 6 and 7)

1. Seat into the vehicle.

NOTICE: Refer to "Notice" on page 10A2-1.

2. Seat retaining bolts.

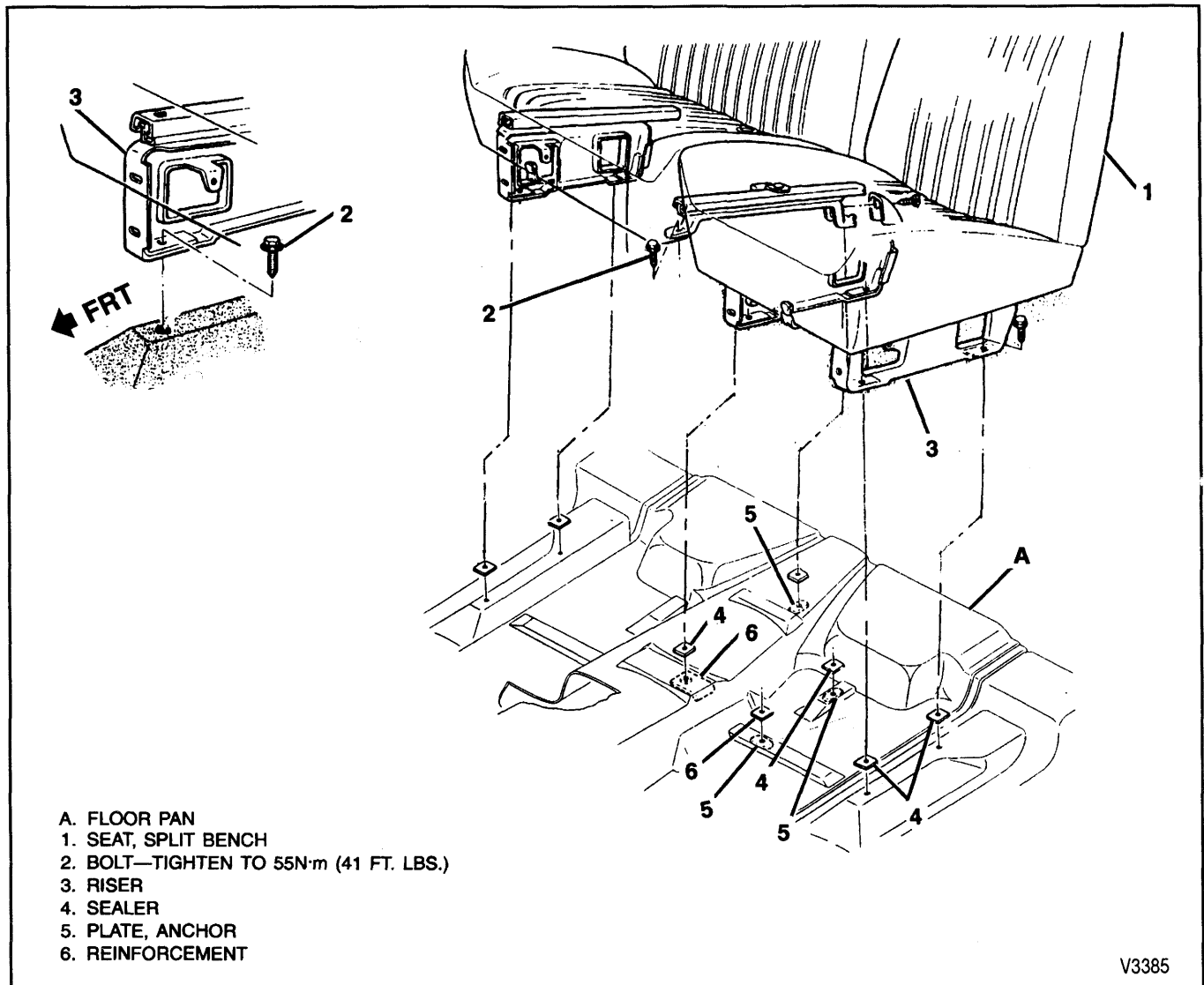


Figure 4—Front Split Bench Seat Mounting

**Tighten**

- Bolts to 55 N·m (41 lbs. ft.).

3. Front and rear leg trim covers (figure 7).

REAR SEAT REPLACEMENT

**Remove or Disconnect (Figures 8 through 12)**

1. Seat retaining bolts.
2. Seat from the vehicle.

**Install or Connect**

1. Seat belts to support assembly, if removed.
2. Seat to the vehicle.

NOTICE: Refer to "Notice" on page 10A2-1.

3. Seat retaining bolts.

**Tighten**

- Refer to figures 8 through 12 for specifications.

REAR SEAT SUPPORT REPLACEMENT (EXTENDED CAB)

**Remove or Disconnect (Figure 8)**

1. Rear seat.
2. Ashtray and panel pocket.
3. Arm rest.
4. Seat belt anchors.
5. Jack cover, jack, and tray (right side only).
6. Lower trim panel mounting screws.

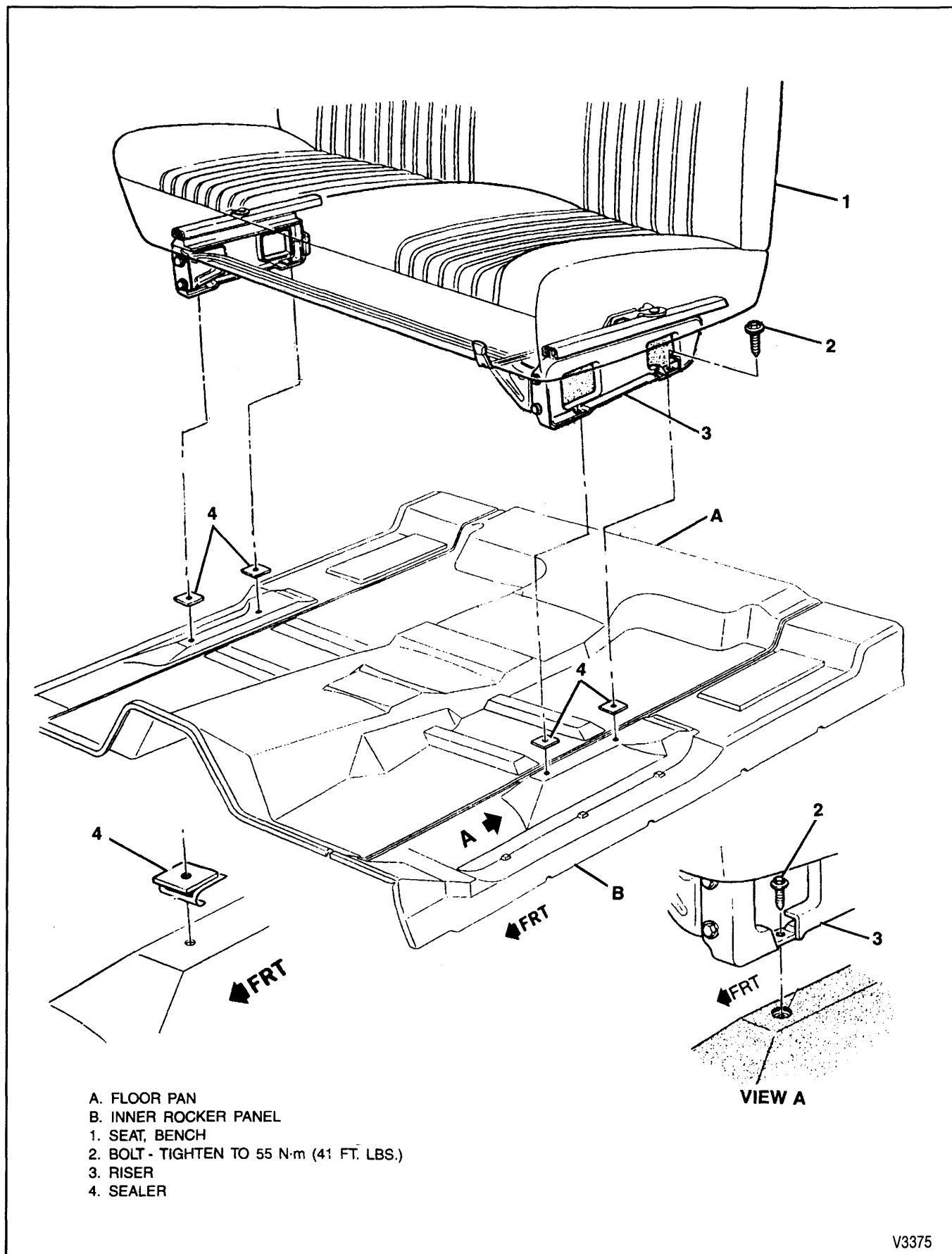


Figure 5—Front Bench Seat Mounting

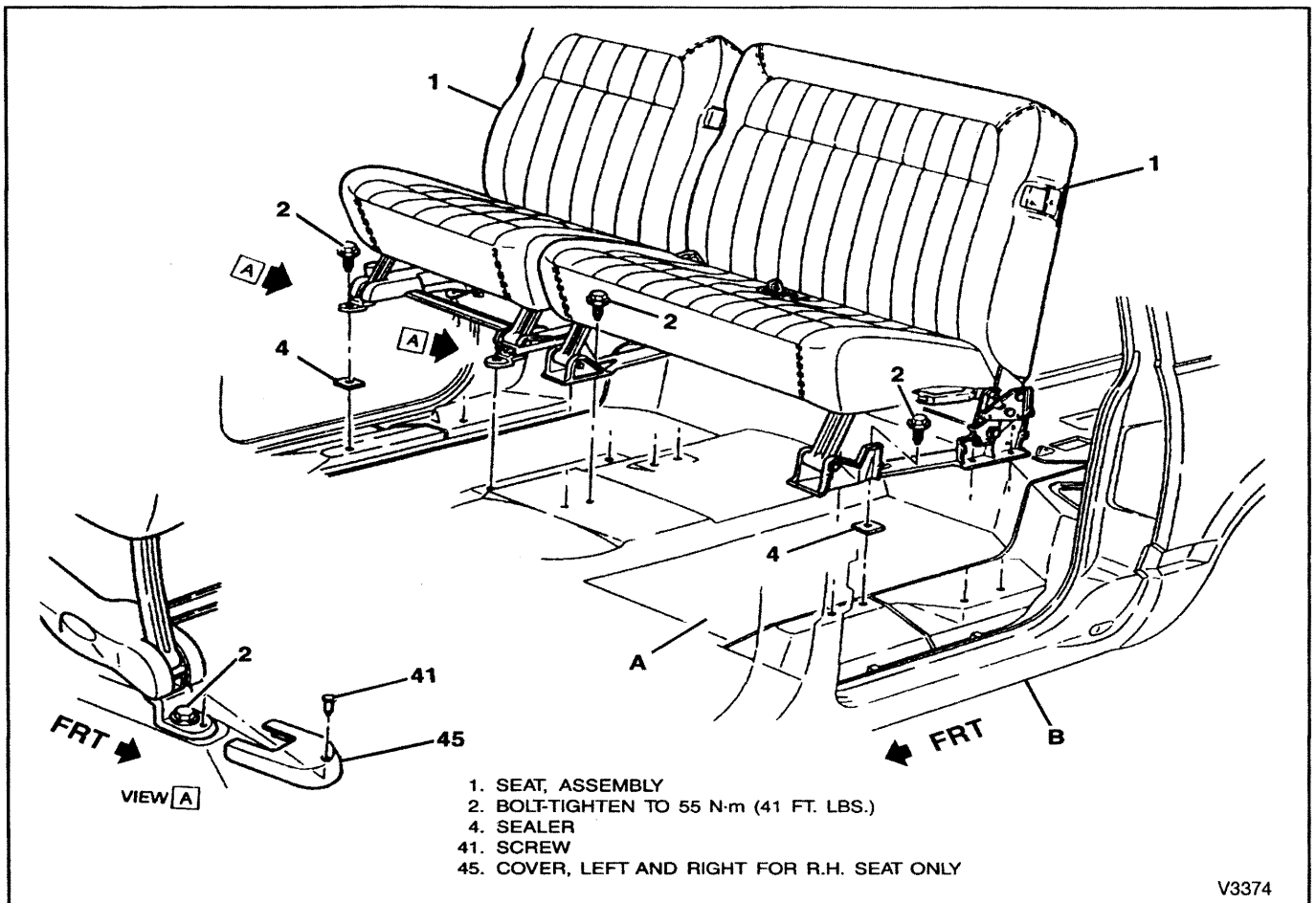


Figure 6—Folding Intermediate Seat Mounting

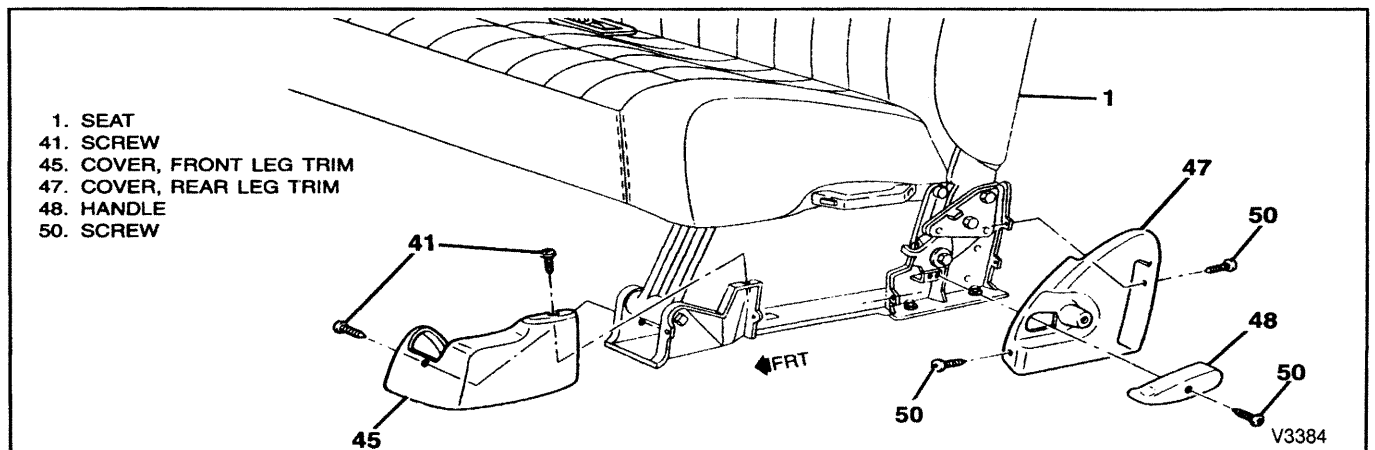


Figure 7—Folding Intermediate Seat Trim Covers

10A2-8 SEATS

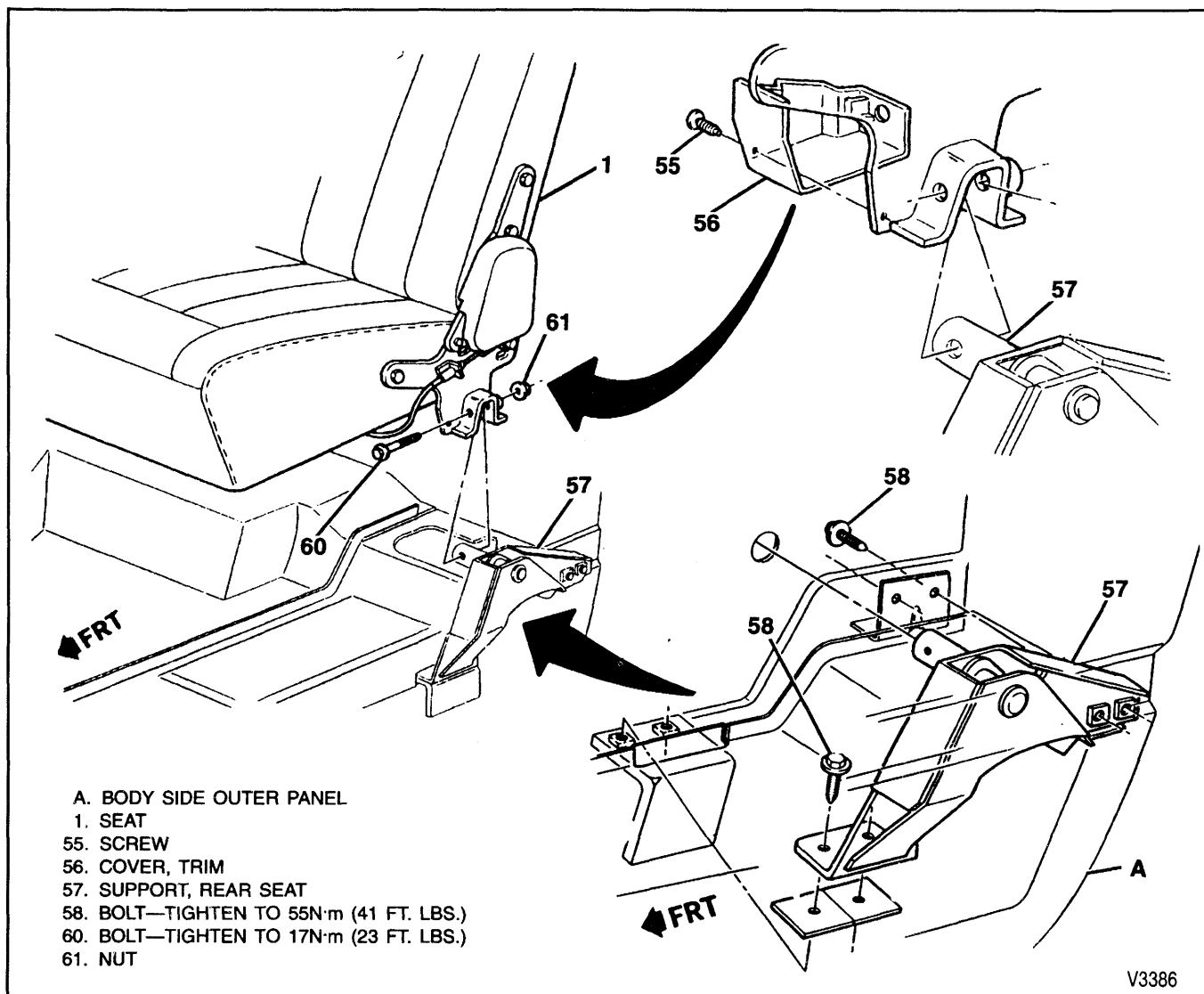


Figure 8—Rear Folding Seat Mounting (Extended Cab)

7. Lower trim panel.
8. Support retaining bolts.
9. Support assembly from the vehicle.

Install or Connect (Figure 8)

1. Support assembly to the vehicle.

NOTICE: For steps 2 and 8, refer to "Notice" on page 10A2-1.

2. Bolts.



Tighten

- Bolts to 55 N·m (41 lbs. ft.).

3. Lower trim panel and screws.
4. Jack tray, jack, and, cover (right side only).
5. Seat belt anchors to the seat assembly.
6. Arm rest.
7. Ash tray and panel pocket.
8. Rear seat and bolts.



Tighten

- Seat retaining bolts to 17 N·m (12 lbs. ft.).

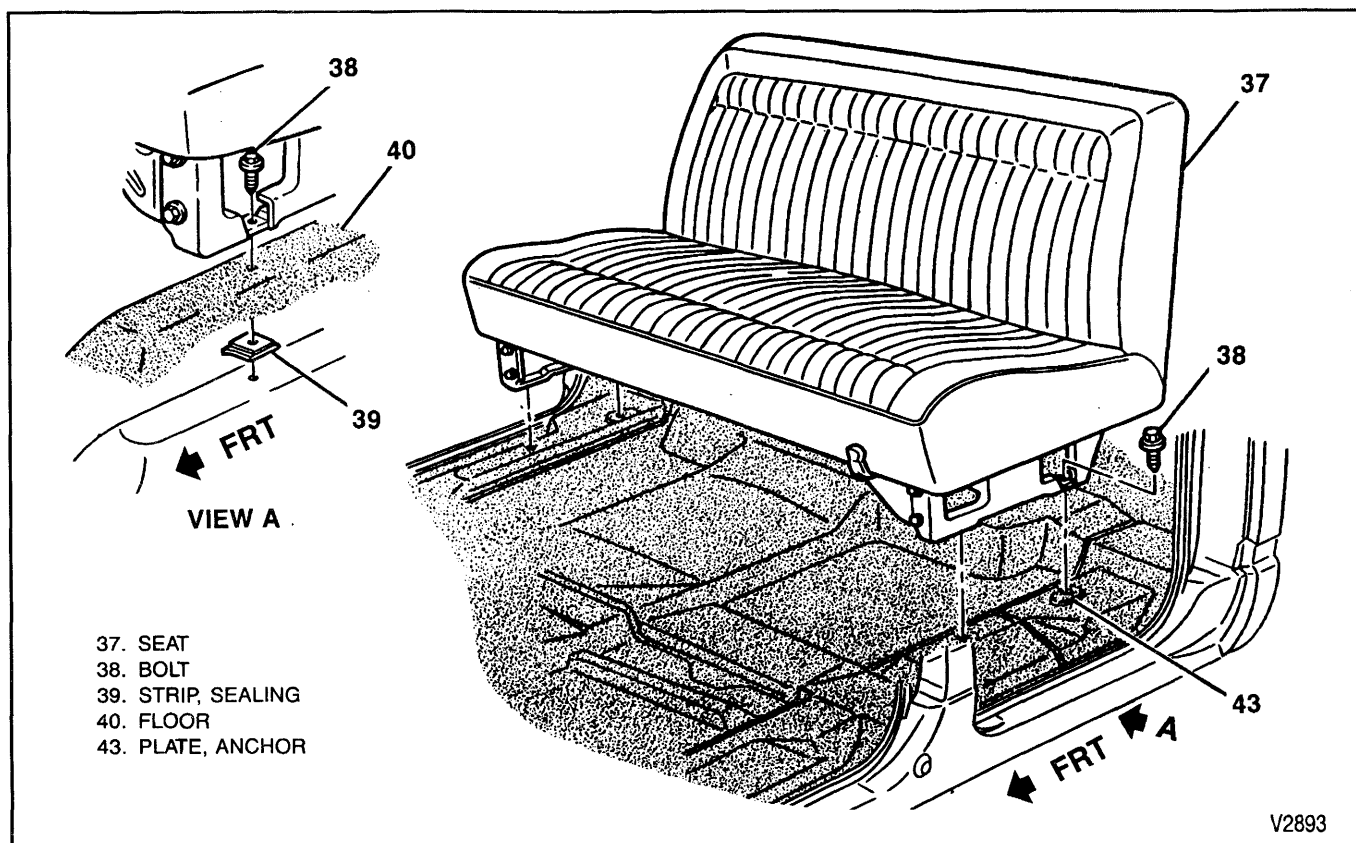


Figure 9—Rear Folding Seat Mounting (Utility)

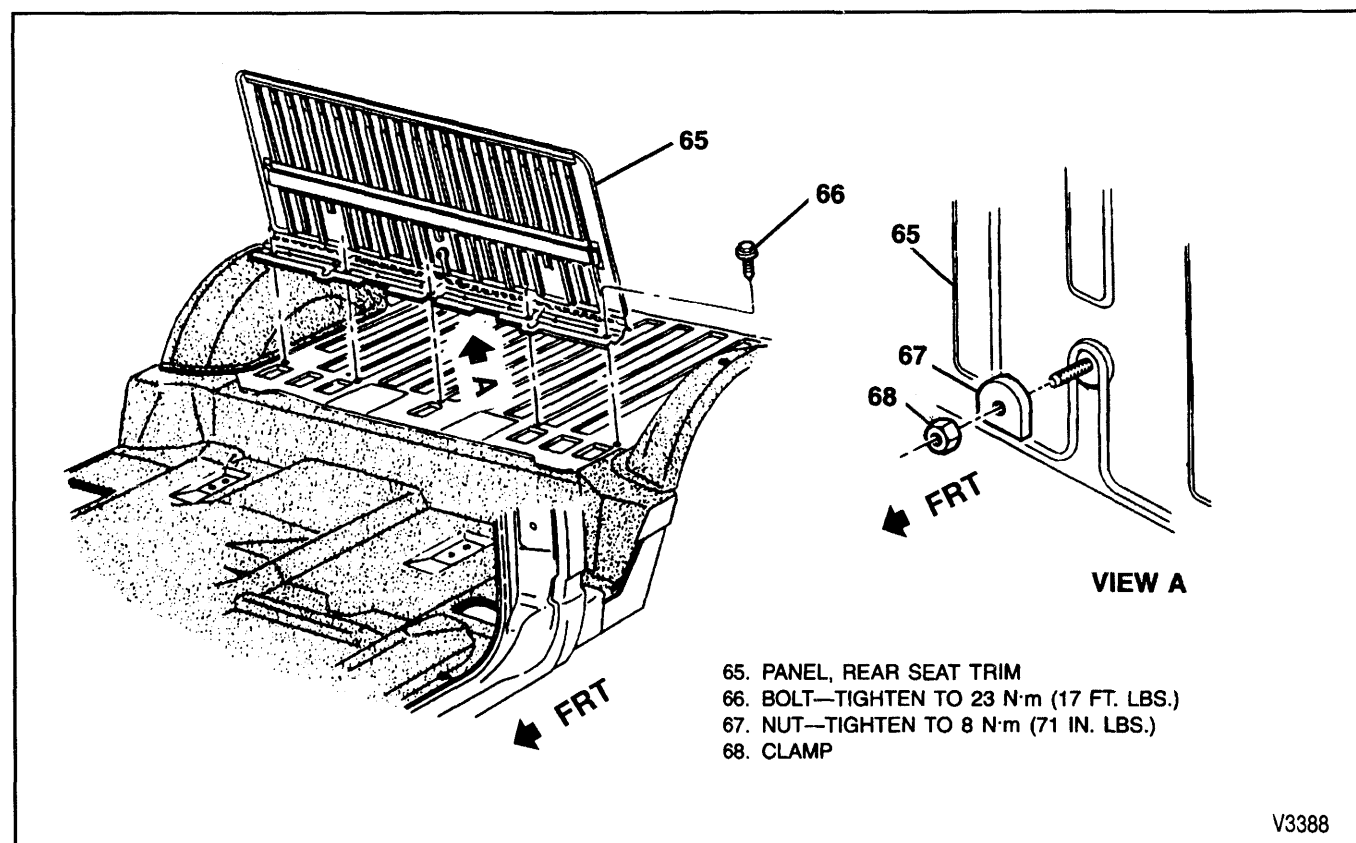


Figure 10—Rear Folding Seat Panel (Utility)

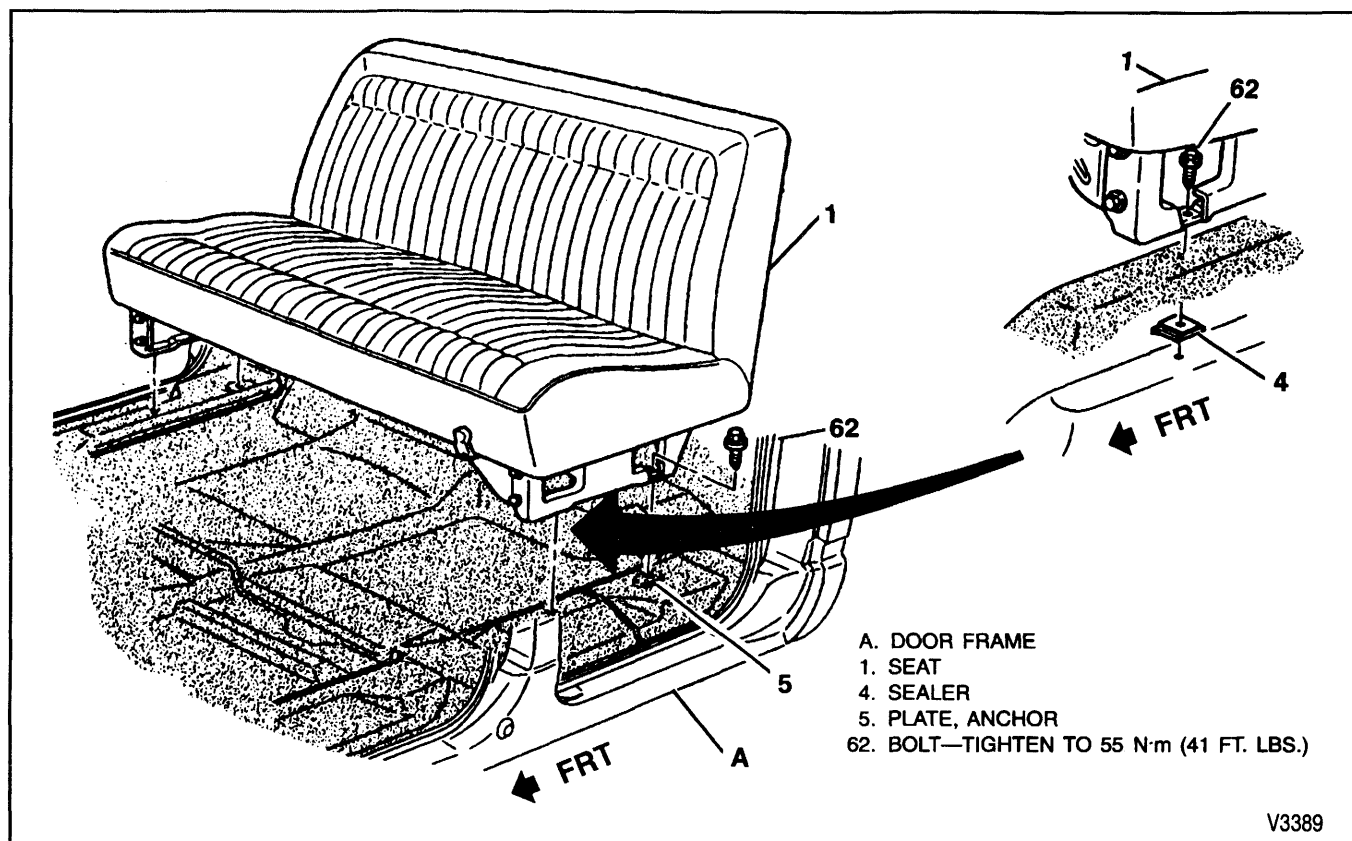


Figure 11—Rear Seat Mounting (Crew Cab)

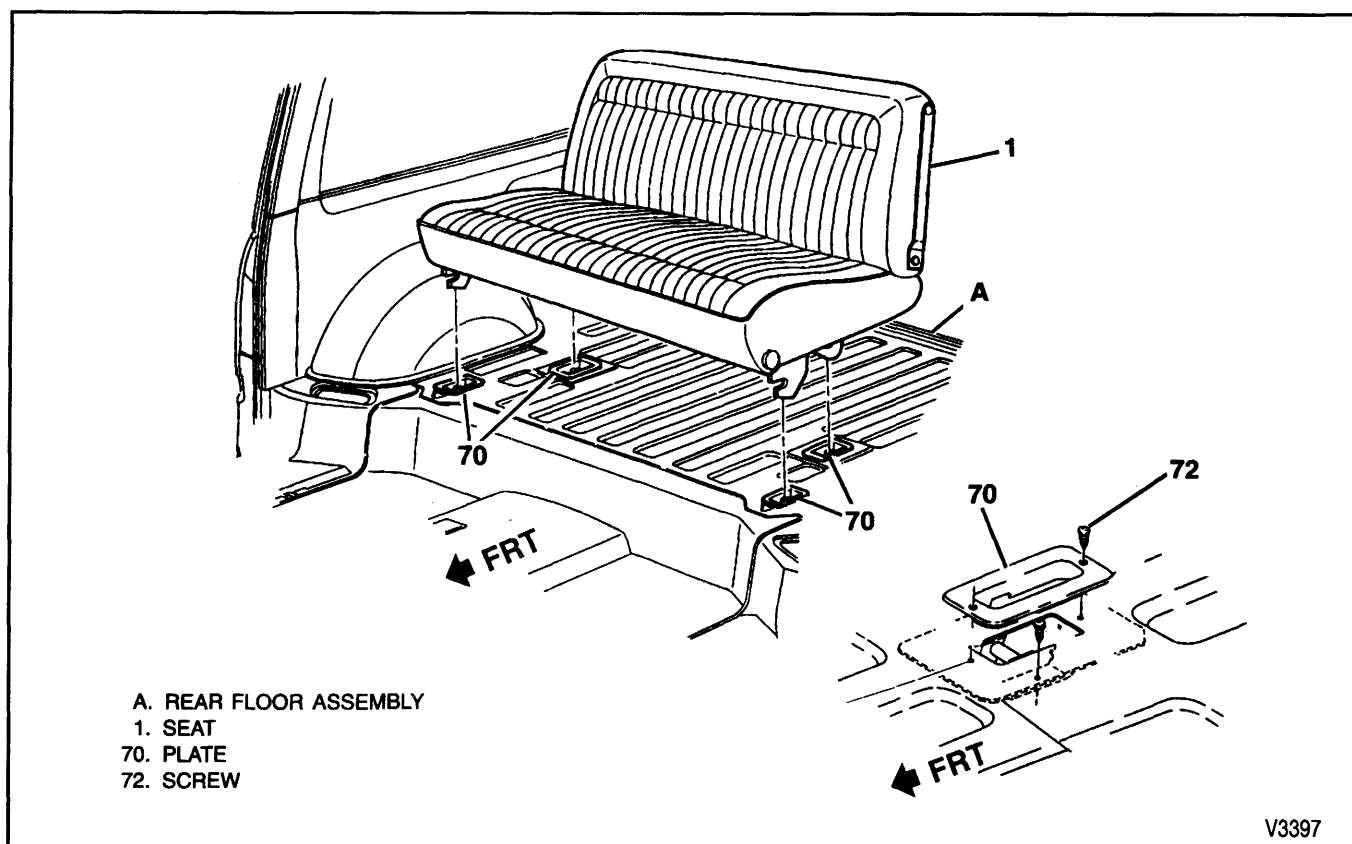


Figure 12—Rear Seat Mounting (Suburban)

SEAT BELTS

NOTICE: Before servicing or replacing lap and shoulder belts, including single loop belt systems, refer to the following precautionary items:

1. Lap and shoulder belts will be serviced as follows:
 - A. All belts will be serviced in complete sets.
 - B. Do not intermix standard and deluxe belts on front or rear seats.
2. Keep sharp edges and damaging objects away from belts.
3. Avoid bending or damaging any portion of the belt buckle or latch plate.
4. Do not bleach or dye belt or strap webbing. Clean with a mild soap solution and water.
5. When installing lap or shoulder belt anchor bolt, start the bolt by hand to ensure that the bolt is threaded straight.
6. Do not attempt repairs on lap or shoulder belt retractor mechanisms to lap belt retractor covers. Replace defective assemblies with new service replacement parts.
7. Do not attempt to remove the seat belt retractor cover. The cover and the long rivet securing the cover to the retractor are not available as service replacement parts.

FRONT SEAT BELT REPLACEMENT



Remove or Disconnect (Figures 13 through 16)

1. Cover from the door pillar anchor plate.
 - Pry the bottom up.
2. Bolt from the door pillar weld nut.
3. Bolt retaining the retractor to the floor panel.
4. Retractor from the vehicle.
5. Cover from the buckle assembly which conceals the nut.
6. Nut from the buckle assembly to floor weld stud.
7. Seat belt warning wire from the buckle assembly (driver's side only).
8. Buckle assembly from the vehicle.



Install or Connect (Figures 13 through 16)

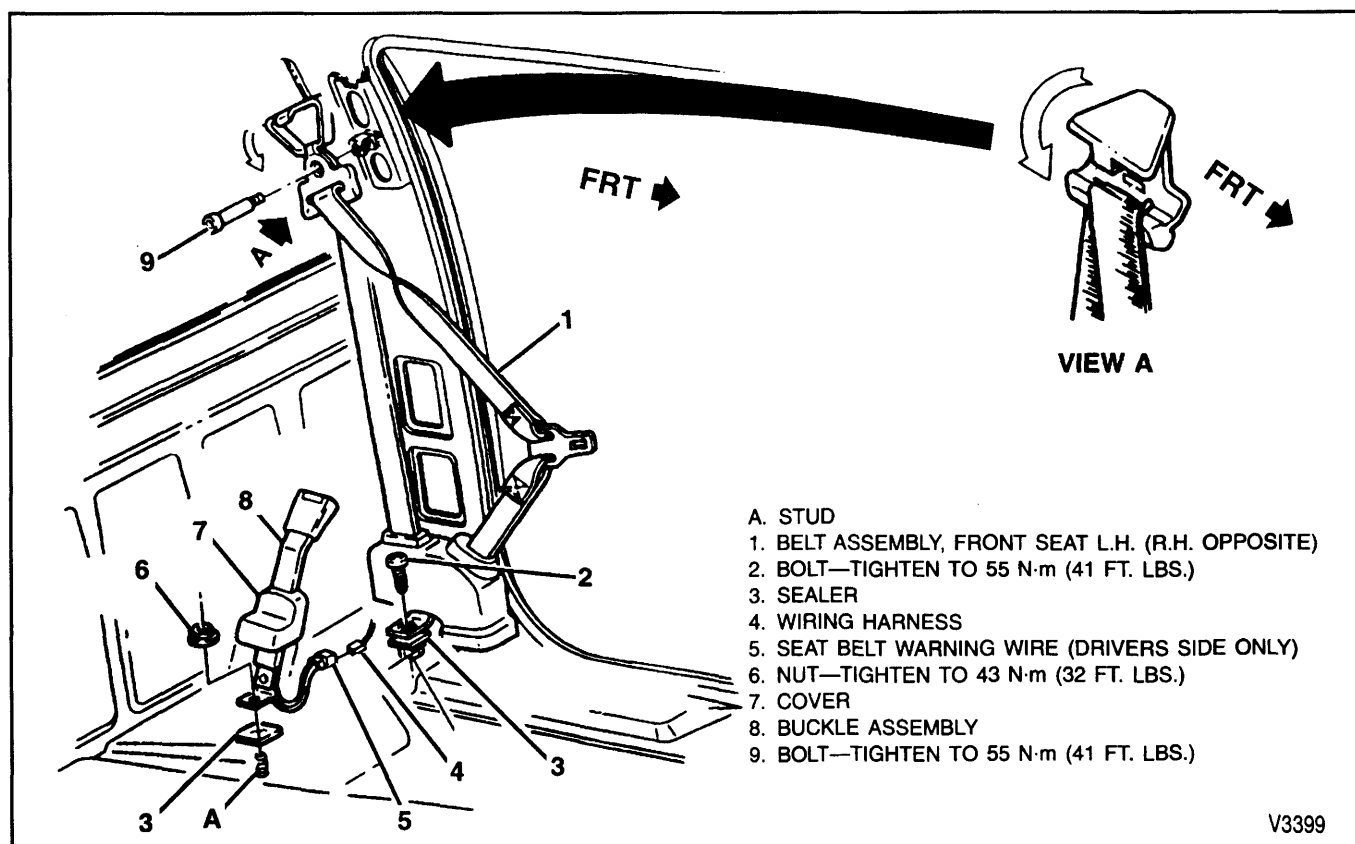
NOTICE: For steps 3 and 6 refer to "Notice" on page 10A2-1.

1. Buckle assembly to the floor panel.
2. Seat belt warning wire to the buckle assembly (driver's side only).
3. Nut to the buckle assembly and onto the floor panel weld stud.



Tighten

- Nut to 43 N.m (32 lbs. ft.).
4. Cover assembly over nut.



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Figure 13—Front Seat Belts (Regular Cab with Bucket Seats)

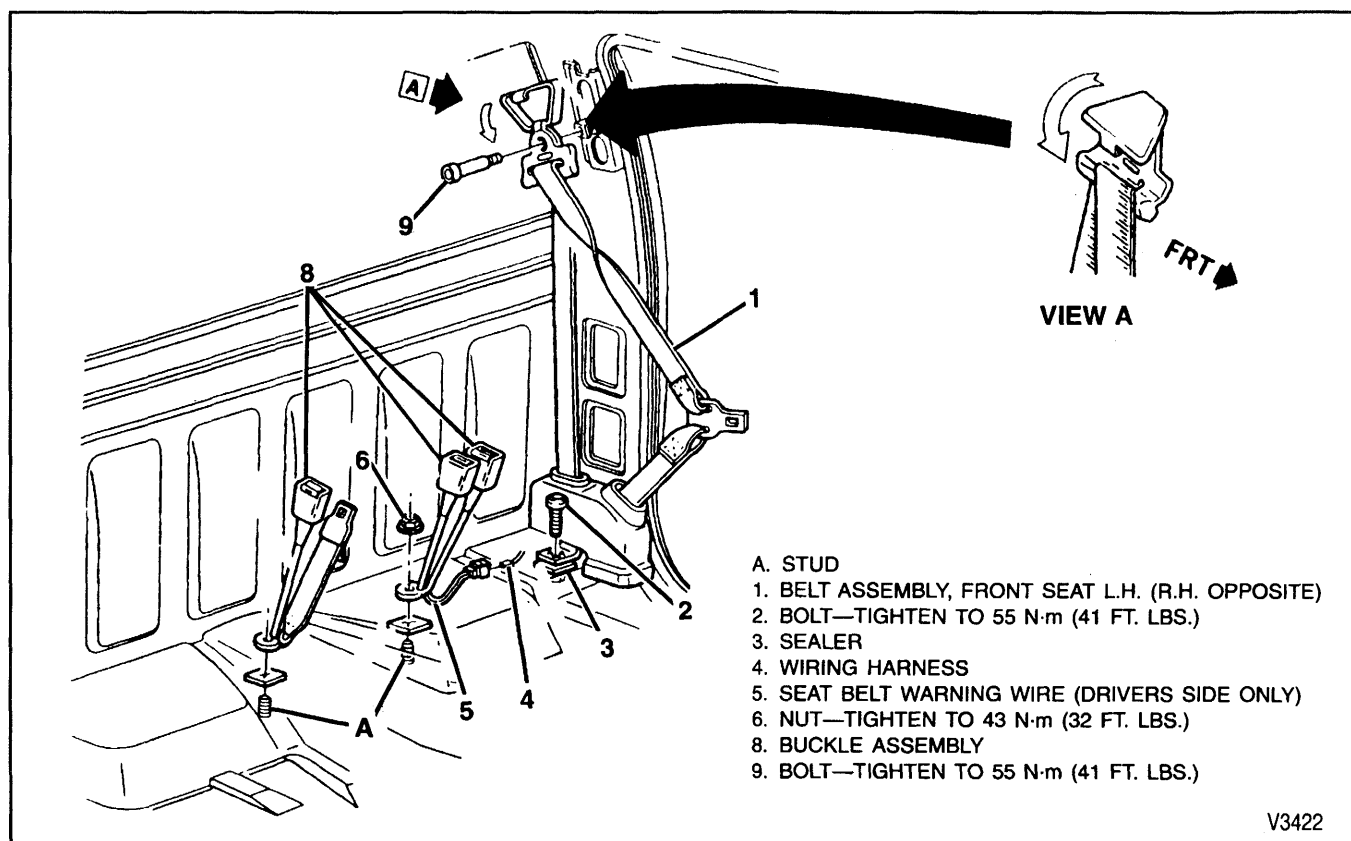


Figure 14—Front Seat Belts (Regular Cab with Bench Seats)

5. Retractor and belt to floor.
6. Bolt through the retractor and into the floor panel weld nut.



- Bolt to 55 N·m (41 lbs. ft.).

7. Bolt through the anchor plate and washer, and into the door pillar weld nut.



- Bolt to 55 N·m (41 lbs. ft.).

8. Cover over the door pillar anchor plate.

REAR SEAT BELT REPLACEMENT



1. Rear seat. Refer to "Rear Seat Replacement."
2. Buckle from the rear seat support assembly.
3. Quarter trim panel. Refer to SECTION 10A4.
4. Bolt and holding the retractor to the body.



1. Buckle assembly to the floor panel stud.

NOTICE: For steps 2, 3, and 5, refer to "Notice" on page 10A2-1.

2. Nuts to the buckle assembly.



- Nuts to 43 N·m (32 lbs. ft.).

3. Bolt through the seat belt retractor to the weld nut.



- Bolt to 55 N·m (41 lbs. ft.).

4. Quarter trim panel. Refer to SECTION 10A4.

5. Bolt to the upper anchor plate.



- Bolts to 55 N·m (41 lbs. ft.).

6. Rear seat. Refer to "Rear Seat Replacement."

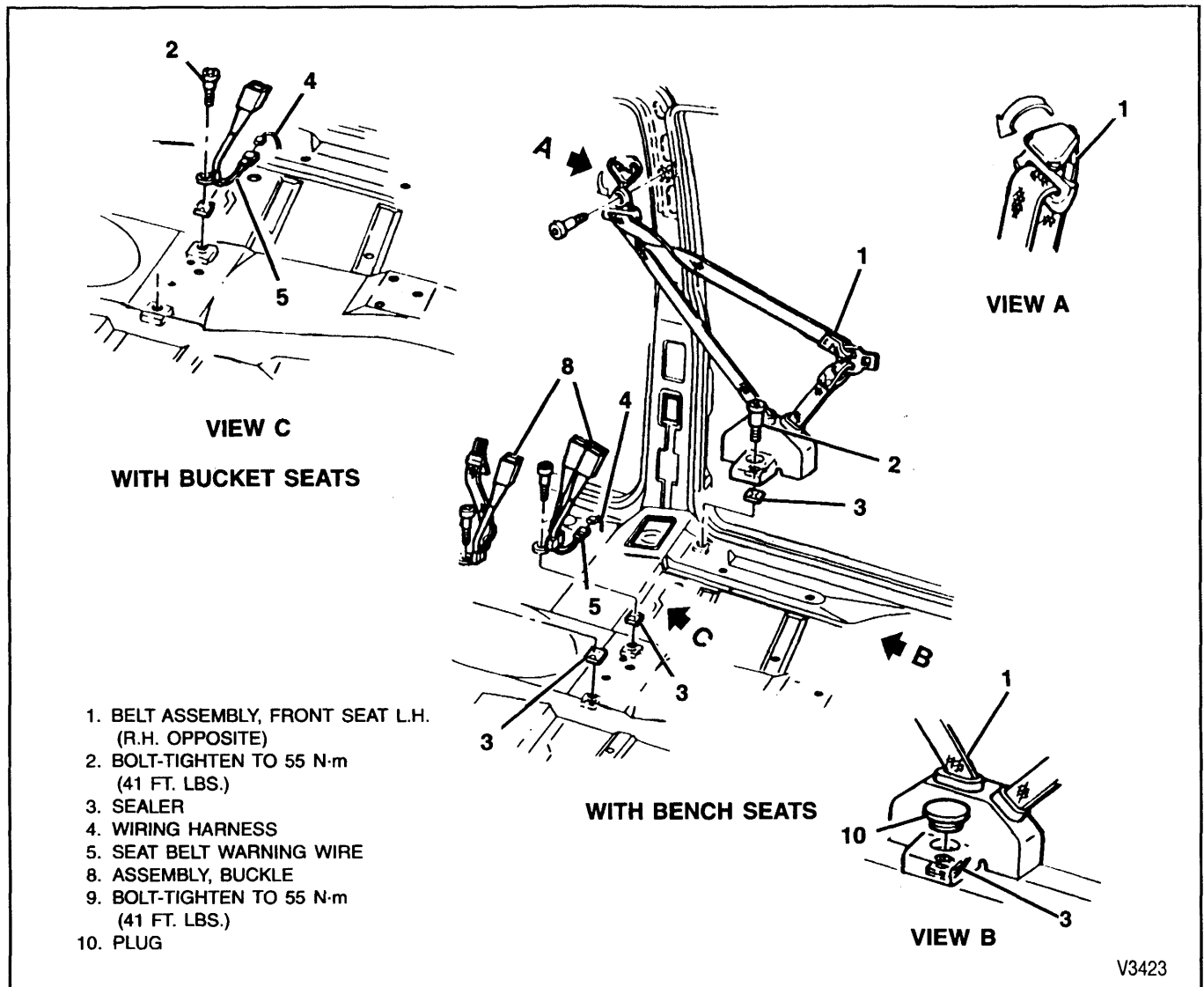


Figure 15—Front Seat Belts (Suburban and Crew Cab)

10A2-14 SEATS

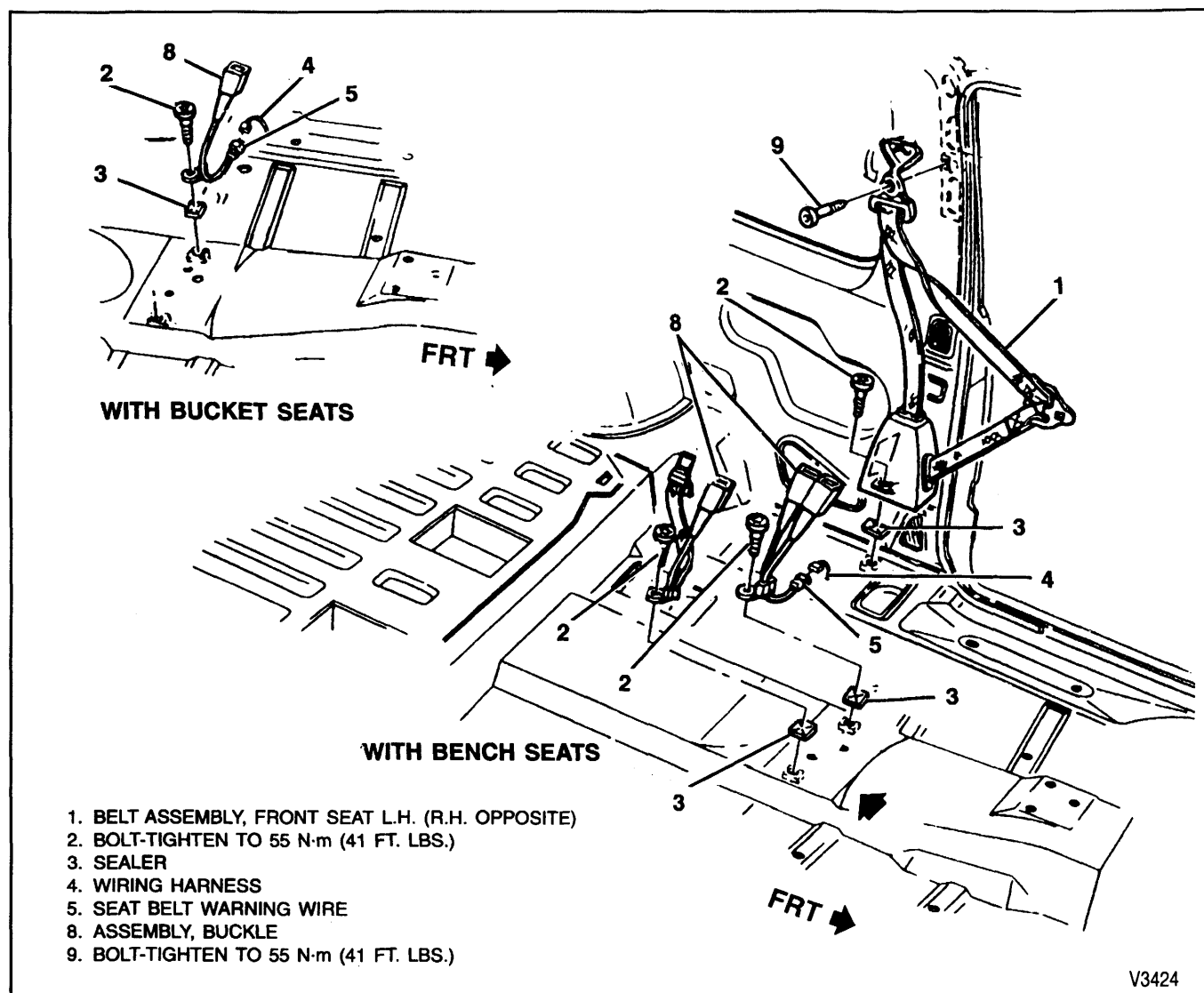


Figure 16—Front Seat Belts (Utility Model)

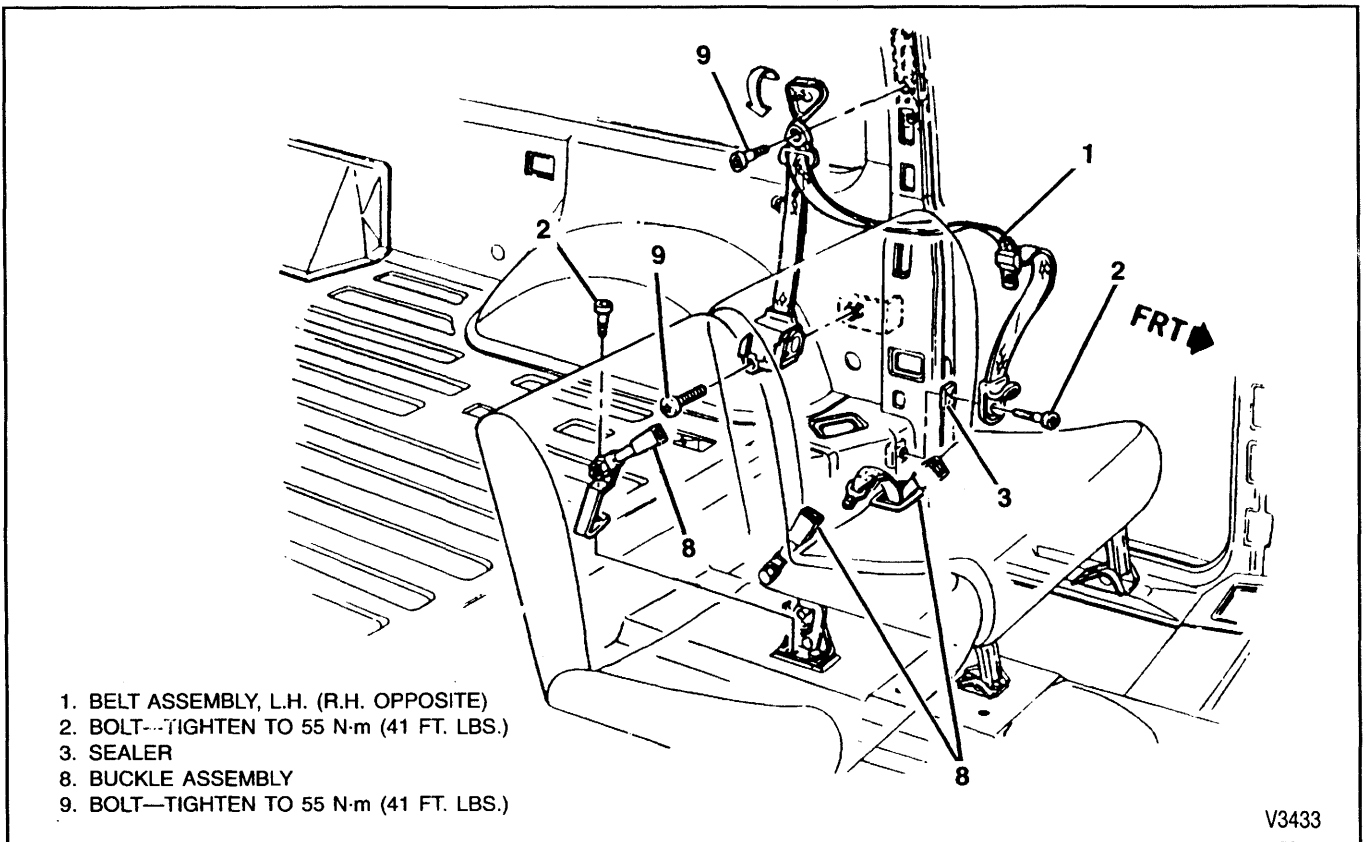


Figure 17—Folding Intermediate Seat Belts (Suburban)

10A2-16 SEATS

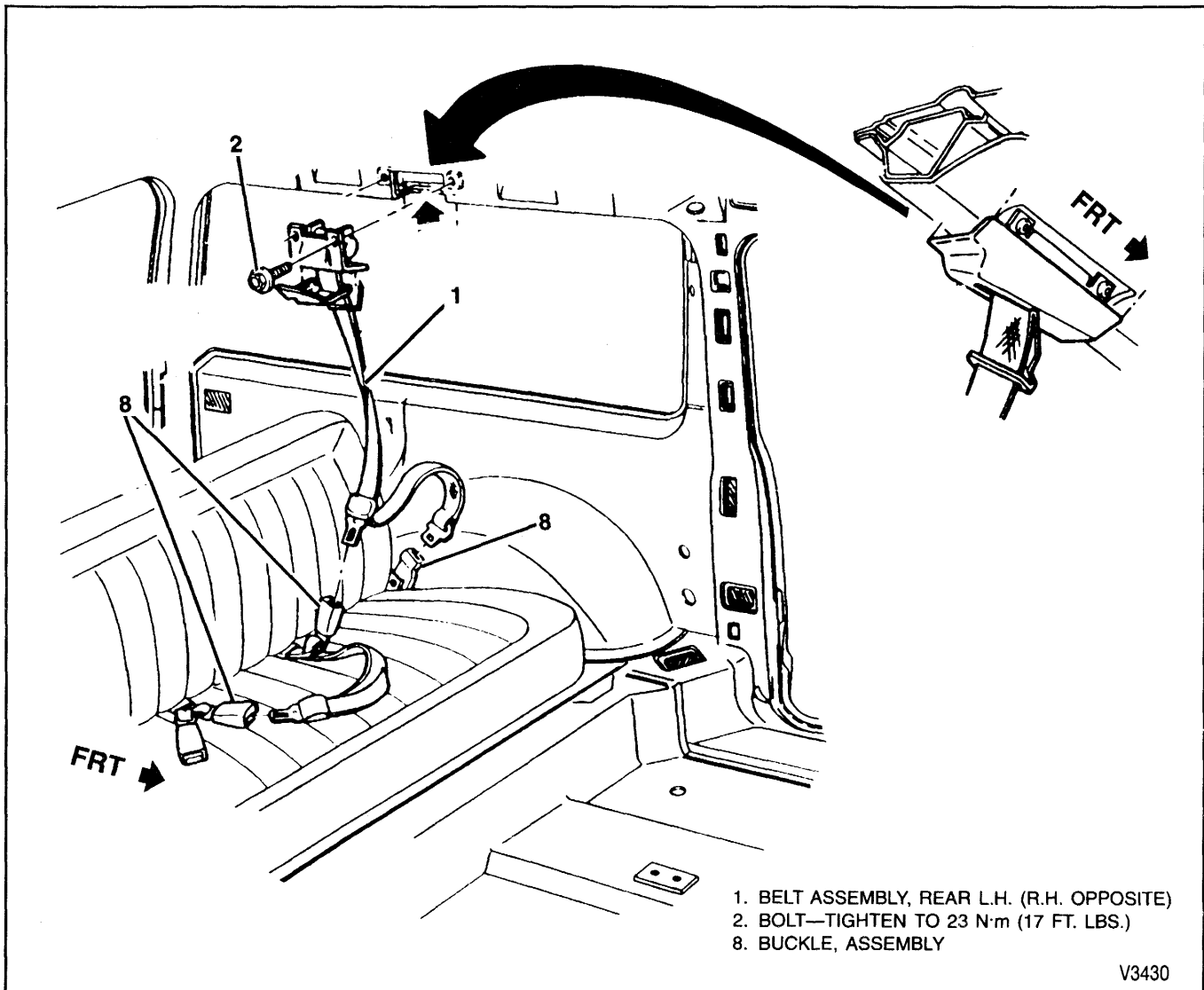


Figure 18—Rear Seat Belts (Suburban with Removable Folding Rear Seat)

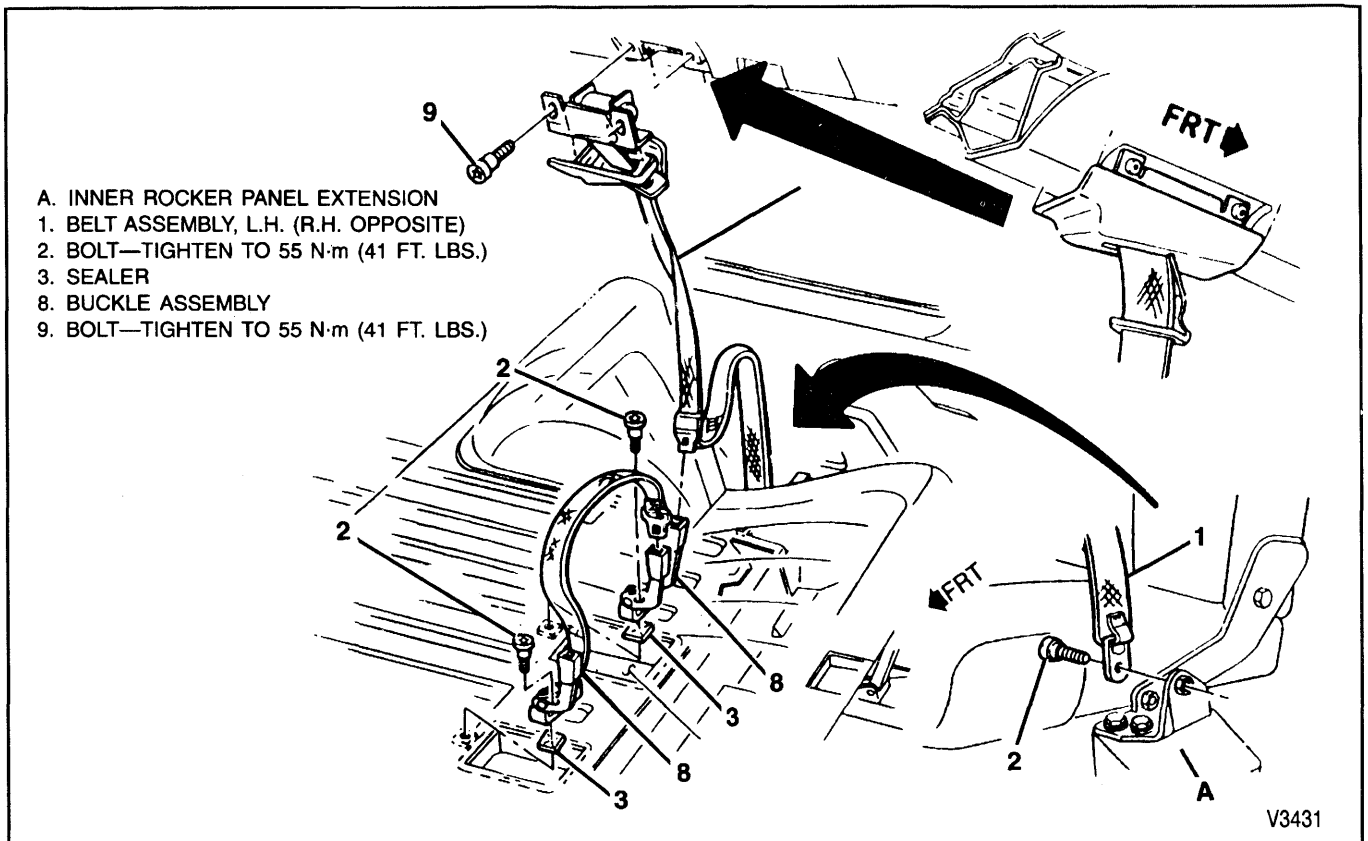


Figure 19—Rear Seat Belts (Utility with Folding Rear Seat)

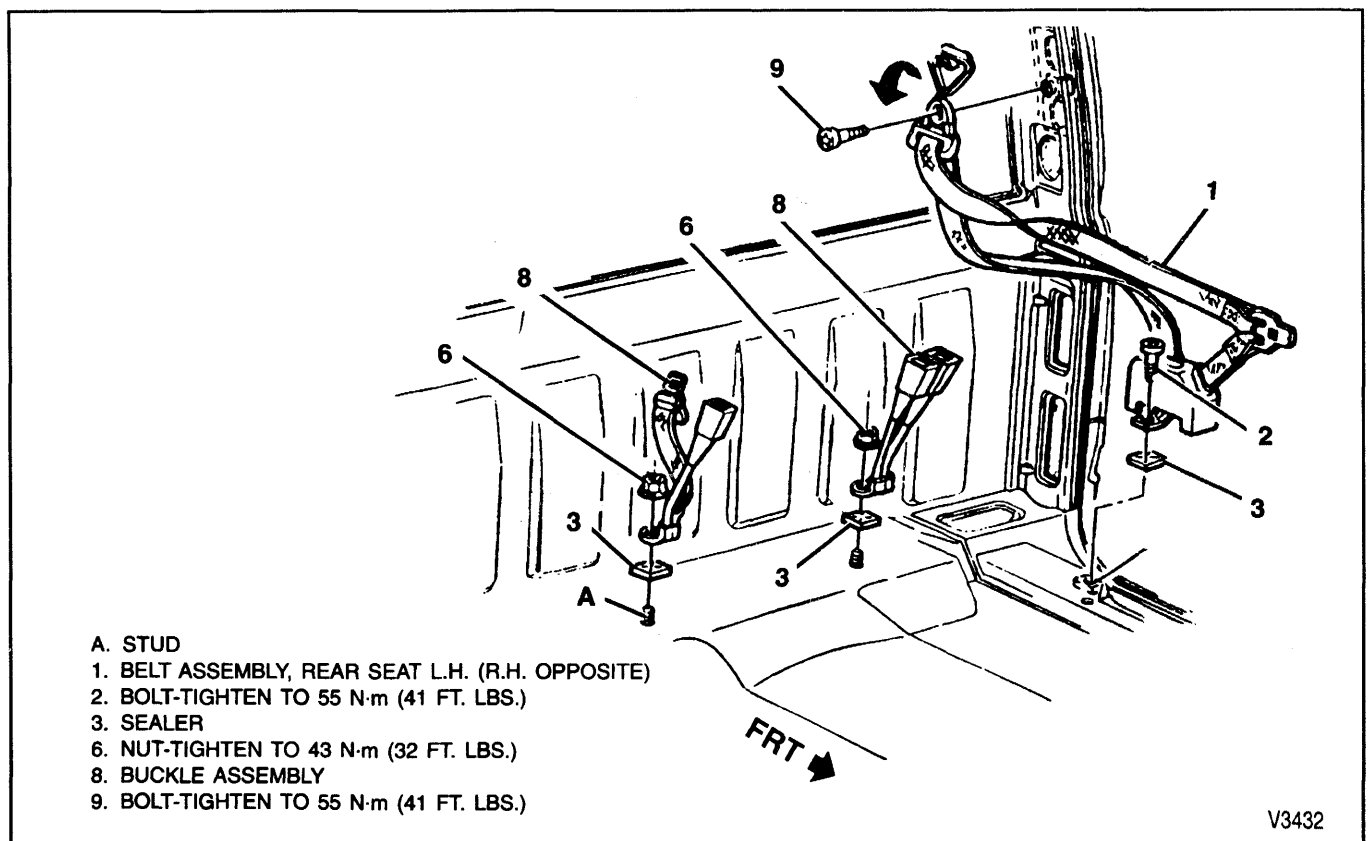


Figure 20—Rear Seat Belts (Crew Cab with Folding Rear Seat)

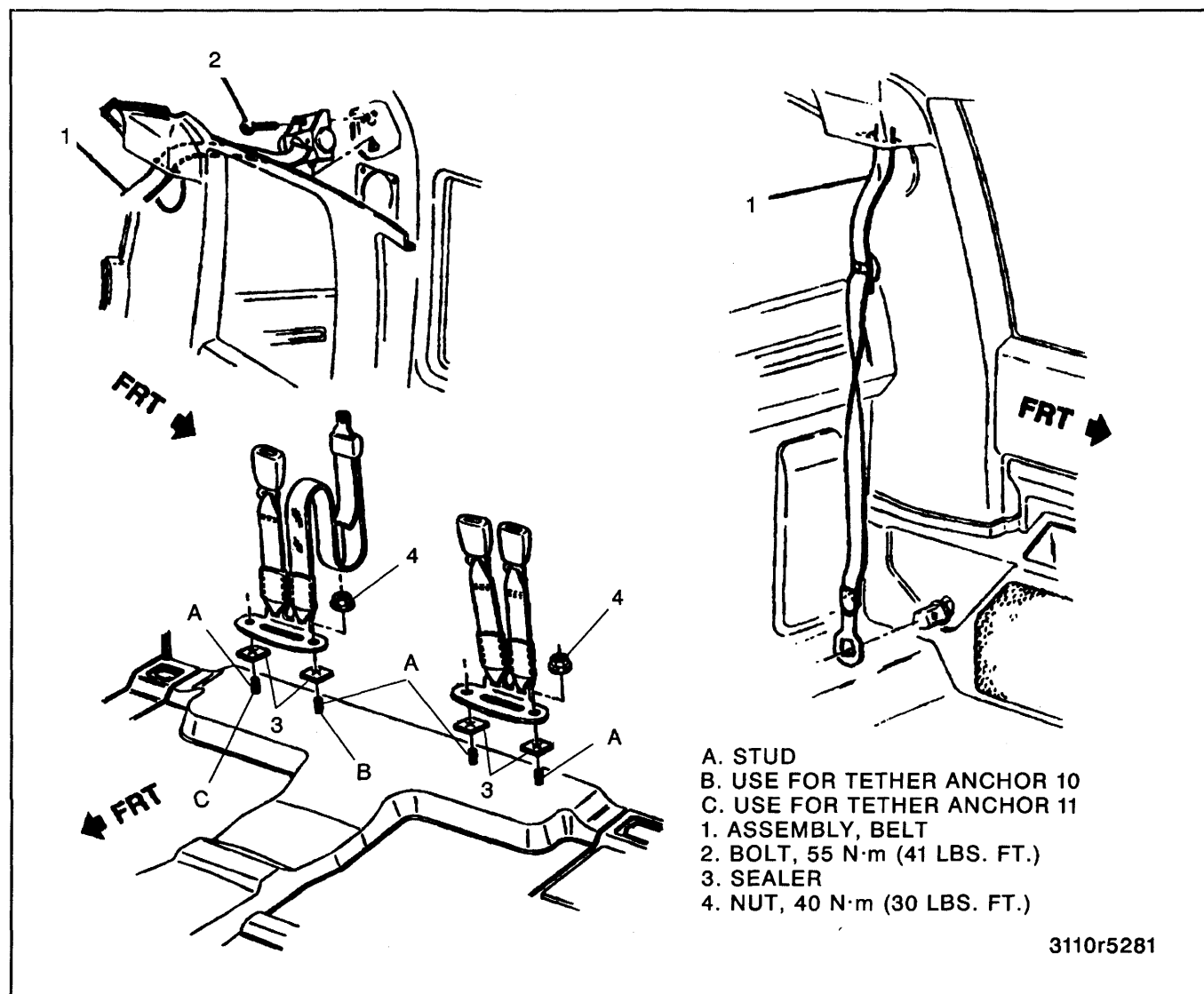


Figure 21—Rear Seat Belts (Extended Cab)

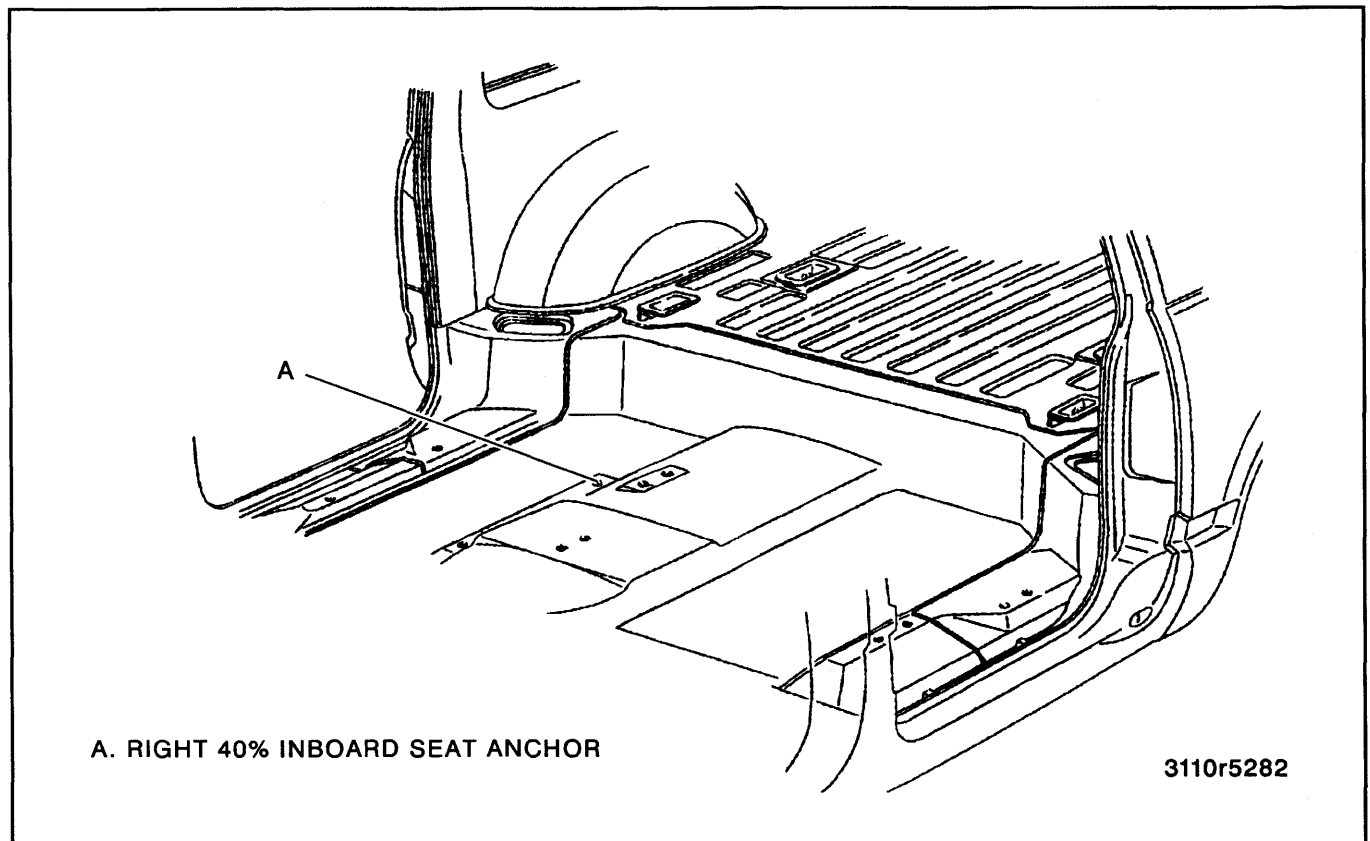


Figure 22—Child Seat Tether Anchor Point

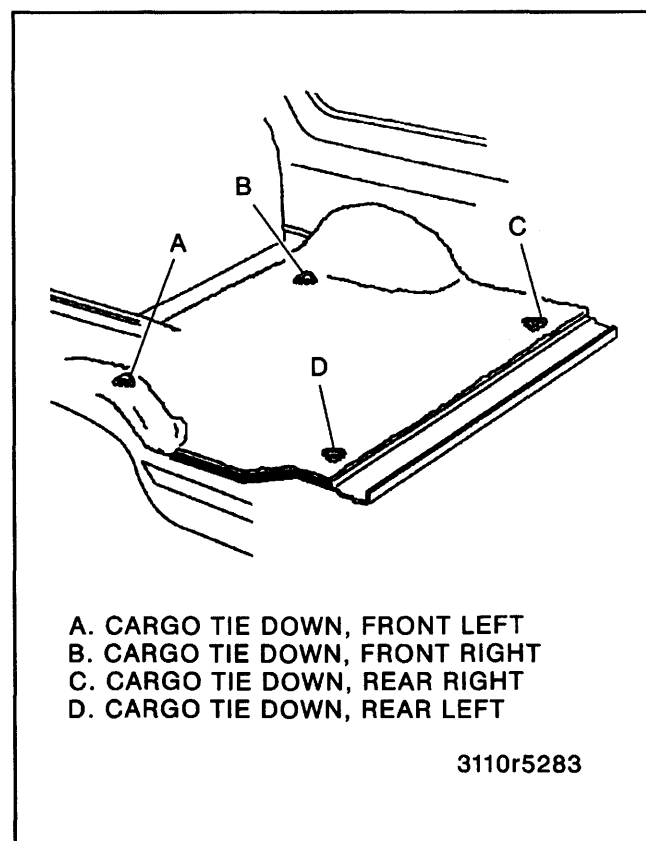


Figure 23—Cargo Tie Downs

TOP TETHER CHILD SEAT ANCHOR POINTS

Seat Position	Suburban				Utility	Crew Cab	Extended Cab		Pickup
	With 2nd Folding Seat (AT5)	Without 2nd Folding Seat (AT5)	With 3rd Seat (AS3)	Without 3rd Folding Seat (AS3)			With 2nd Seat (AM7)	Without 2nd Seat (AM7)	
Front Seat Center	1	2	X	X	1	1	1	10	9R
Front Seat Right	3	2	X	X	1	1	1	11	9R
2nd Seat Center Folding	X	X	4	NR	X	X	X	X	X
2nd Seat Left Folding	X	X	4	5	X	X	X	X	X
2nd Seat Right Folding	X	X	12	6	X	X	X	X	X
3rd Seat Center	X	X	NR	X	X	X	X	X	X
3rd Seat Left	X	X	7	X	X	X	X	X	X
3rd Seat Right	X	X	8	X	X	X	X	X	X
2nd Center	X	X	X	X	NR	9C	9C	X	X
2nd Seat Left	X	X	X	X	7	9L	9L	X	X
2nd Seat Right	X	X	X	X	8	9R	9R	X	X
1	Hook tether into 2nd seat center occupant lap belt latch plate if 2nd seat is unoccupied.*								
2	Use anchor hole located in figure 22.								
3	Use GM P/N 15971501 to latch tether to buckle on 2nd 40% seat if seat is unoccupied*.								
4	Hook tether into 3rd seat center occupant lap belt latch plate and pull taught if 3rd seat is unoccupied*.								
5	Use left front cargo tie down located in figure 23.								
6	Use right front cargo tie down located in figure 23.								
7	Use left rear cargo tie down located in figure 23.								
8	Use right rear cargo tie down located in figure 23.								
9L	Refer to "top strap tether back panel installation" below. Drill anchor hole between scallops on the left side of back panel.								
9R	Refer to "top strap tether back panel installation" below. Drill anchor hole between scallops on the right side of back panel.								
9C	Refer to "top strap tether back panel installation" below. Drill anchor hole between scallops centerline back panel.								
10	Use stud in floor located in figure 21.								
11	Use stud in floor located in figure 21.								
12	Use GM P/N 15971501 to latch tether into 3rd seat buckle directly behind child seat location if 3rd seat buckle is unoccupied*.								
X	Not applicable.								
NR	Not recommended for use with child seat that has a top tether.								
*	If seat is occupied the child seat should be placed in a rear seat position that will allow the use of the cargo tie downs on Suburban and Utility models or back panel anchor on pickup, extended cab, and crew cab models. Use chart above for tether locations.								

T3166

TOP TETHER BACK PANEL INSTALLATION


Install or Connect (Figure 25)
Tools Required:

J 24595-C Trim Pad Clip Remover

1. Remove the seat. Refer to "Rear Seat Replacement."
2. Pry the trim panel off the sheet metal below the rear window with J 24595-C.
3. Pry the carpet off the rear panel with J 24595-C.
4. Locate the position where the hole will be drilled from inside the cab. The hole may be located either 109 mm (4.3 inches) or 545 mm (21.4 inches) outboard from the centerline or center line

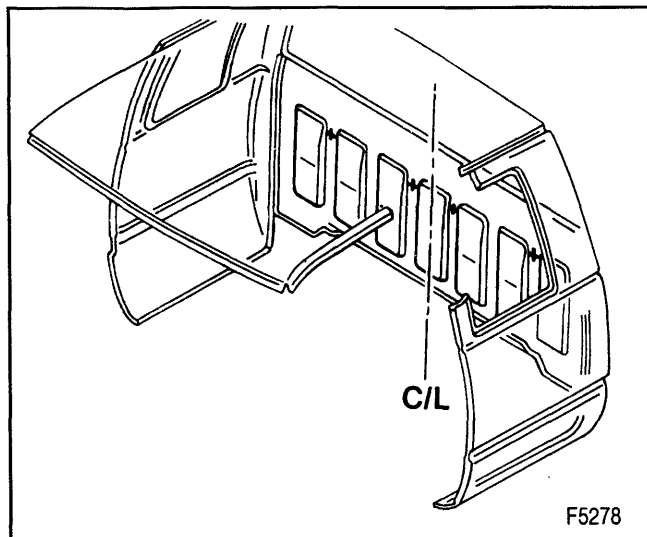


Figure 24—Child Restraint Anchor Installation

of the back panel and 42 mm (1.65 inches) below the horizontal sheet metal panel (figures 24 and 25).

5. Drill a 9-mm (3/8-inch) hole through the sheet metal from inside the cab. Use a drill stop to prevent damage to the pickup box.
6. Place the washer on the bolt and apply a bead of sealer around the hole in the washer.
7. Using a clamping tool, feed the bolt through the hole from the outside of the cab.
8. Thread the nut on the bolt, holding the bolt head with an extended length wrench.

NOTICE: Refer to "Notice" on page 10A2-1.



Tighten

- Nut to 30 N·m (22 lbs. ft.).

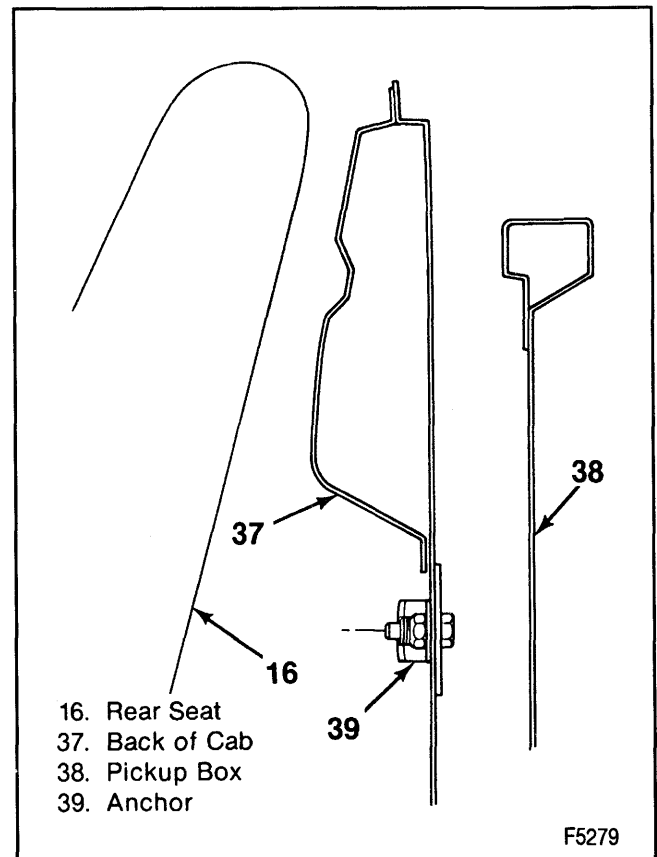


Figure 25—Anchor Installation (Pickup Models)

9. In the extended cab, the length of the bolt may interfere with the rear seat when it is in the folded position. If this occurs, saw off the end of the bolt, leaving at least two threads visible from the end of the nut.

Note: In the event the child seat anchorage is removed, the 9-mm (3/8-inch) diameter hole must be properly resealed.

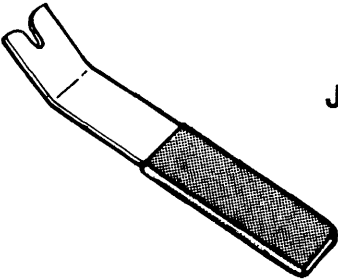
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener	N·m	Ft. Lbs.
Child Restraint Anchor Nut.....	30	22
Front Seat Belt Anchor Plate Bolts.....	55	41
Front Seat Belt Buckle		
Assembly Bolts (Extended Cab).....	55	41
Assembly Nuts (Regular Cab).....	42	32
Front Seat Belt Retractor Bolts.....	55	41
Front Seat Retaining Bolts.....	55	41
Rear Seat Belt Buckle Assembly Nuts.....	42	32
Rear Seat Belt Retractor Bolts.....	55	41
Rear Seat Retaining Bolts.....	17	12
Rear Seat Support Bolts.....	40	30
		T2154

SPECIAL TOOLS

1.



J 24595-C

1. Trim Pad Clip Remover

F5280

SECTION 10A3

WINDOWS

CAUTION: When replacing stationary glass; such as a windshield, back window, or hatch roof window, urethane adhesive (P/N 12345633 or equivalent) must be used to maintain original installation integrity. Failure to use urethane adhesive will result in poor retention of the windshield which may allow unrestrained occupants to be ejected from the vehicle with resulting personal injury.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: If a window is cracked but still intact, it should be crisscrossed with masking tape to reduce the risk of damage to the vehicle.

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ON-VEHICLE SERVICE

WINDSHIELD SERVICE

CAUTION: Always wear heavy gloves and safety glasses when handling glass to minimize the risk of injury.

When replacing a cracked windshield, it is important that the cause of the crack be determined and the condition corrected before a new window is installed. The cause of the crack may be an obstruction or high spot

somewhere around the flange of the opening. Cracking may not occur until pressure from the high spot or obstruction becomes particularly high due to winds, extremes of temperature, or rough terrain. Suggestions of what to look for are described later in this section under "Inspection."

If a windshield is broken, the glass may already have fallen or been removed from the adhesive. Often, however, it is necessary to remove a cracked or otherwise imperfect windshield that is still intact.

10A3-2 WINDOWS

If a crack extends to the edge of the window, mark the point where the crack meets the reveal molding. (Use a piece of chalk and mark the point on the cab, next to the reveal molding). Later, when examining the flange of the opening for a cause of the crack start at the point marked.

Before removing the window cover the instrument panel and the surrounding sheet metal with protective covering.

WINDSHIELD REMOVAL (BROKEN WINDSHIELD)

CAUTION: Always wear heavy gloves and safety glasses when handling glass to avoid the risk of injury.

↔ Remove or Disconnect (Figure 1)

Tools Required:

J-24709-01, Urethane Glass Sealant Remover
(Hot Knife—115 Volt)

J-24402-A, Glass Sealant Removal Knife

- Place protective coverings around the window removal area.

1. Windshield wiper arms.
2. Radio antenna mast.
3. Cowl vent grille.
4. Windshield stop screws.
5. Rear view mirror.

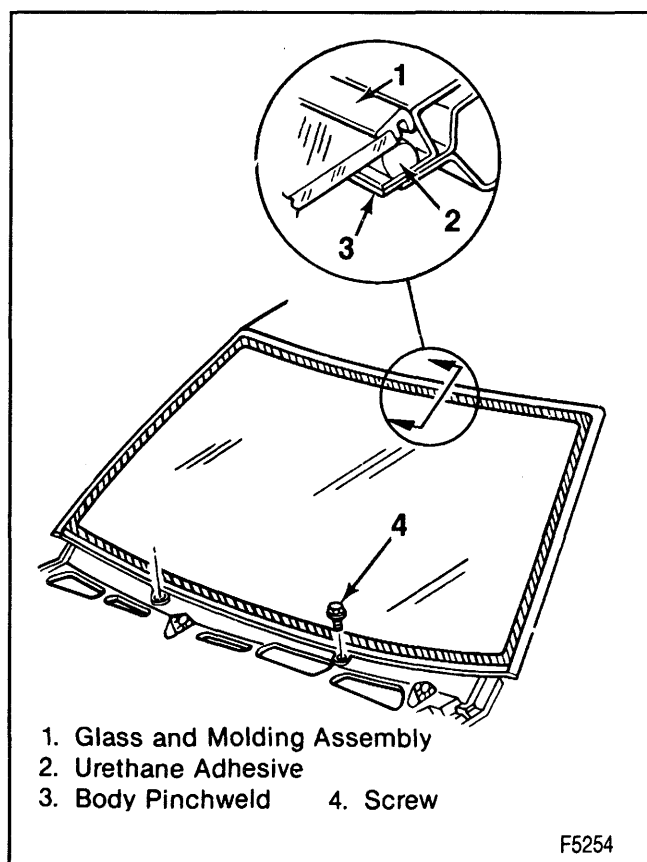


Figure 1—Windshield Assembly

6. Door opening seals, windshield garnish moldings, and speaker covers.

- Cut the molding from the window with a razor-type knife taking care not to damage the paint.
- Work from the outside.

NOTICE: If a window is cracked but still intact, it should be crisscrossed with masking tape to reduce the risk of damage to the vehicle.

7. Windshield glass using J-24709-01 or J-24402-A.

- A. Insert the blade between the glass and urethane.
- B. Keep the blade against the window edge, and cut the adhesive from the windshield.
- C. Use help to remove the windshield.



Clean

- Loosened adhesive from the pinchweld flange by wiping with a dry cloth.
- Do not attempt to scrape away old adhesive still attached. The paint could be damaged.

WINDSHIELD REMOVAL (UNDAMAGED WINDSHIELD)

CAUTION: Always wear safety glasses and heavy gloves when working with glass to avoid the risk of injury.



↔ Remove or Disconnect (figure 1 and 2)

Tools Required:

J-36020 Windshield Remover

1. Windshield wiper arms.
2. Radio antenna mast.
3. Cowl vent grille.
4. Windshield stop screws.
5. Rear view mirror
6. Radio speaker grilles.
7. Windshield pillar trim from both sides of the vehicle and pull the door seal back from the windshield area.
 - A. Using J 36020, insert one end of the wire through the urethane adhesive to the interior of the vehicle and wrap each end of the wire around each handle. Or cut a 6-foot length of 0.020-inch piano wire. Insert one end of the wire through the adhesive around the windshield and wrap each end of the wire around a suitable handle.
 - B. Spray a liquid soap solution around the entire perimeter of the windshield so the urethane is wet.
 - C. With one person at each end of the wire, work the wire back and forth exerting pressure against the urethane. Continue this action until all of the urethane has been cut and the windshield is loose.

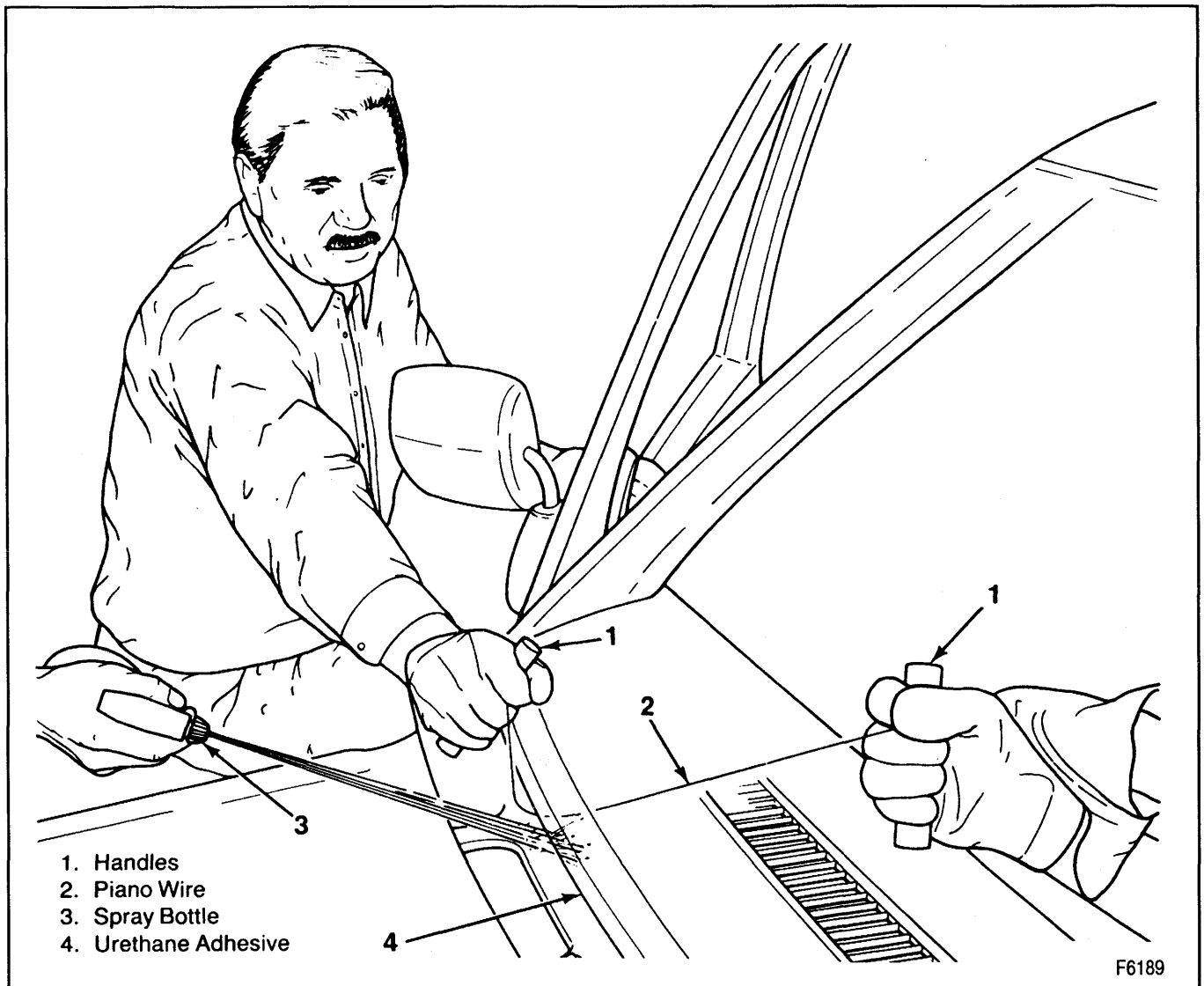


Figure 2—Cutting the Window from the Frame

! Important

* When working the wire back and forth, follow these precautions:

1. To protect the instrument panel from being damaged during the cutting action of the wire, place a cloth or piece of cardboard between the wire and instrument panel pad.
2. When working the wire back and forth do not allow the wire to make contact with the glass.
3. Periodically spray soap solution ahead of the wire until the urethane has been completely cut.
1. Glass from the vehicle with the aid of a helper.

INSPECTION

An inspection of the flange of the windshield opening, reveal molding, and glass may reveal the cause of a broken windshield. This can help prevent future breakage.

Look for high weld or solder spots, hardened spot weld sealer, or any other obstruction or irregularity in the flange. Also, check the cowl vent grille for contact with the windshield.

SERVICE KITS

To replace a urethane adhered windshield, use GM windshield sealer preparation kit P/N 1052420 and GM adhesive caulking kit P/N 12345633 or equivalent. Materials in the GM windshield sealer preparation kit P/N 1052420 kit include:

1. Rubber cleaner.
2. Rubber primer.
3. Pinch weld flange primer.
4. Applicators.
5. Desiccant.
6. Instruction sheet.

Materials in the GM adhesive caulking kit P/N 12345633 kit include:

1. One tube of adhesive material.
2. Clear glass primer.
3. Blackout primer.
4. Application dauber
5. Polyethylene applicator nozzle.
6. Instruction sheet.

10A3-4 WINDOWS

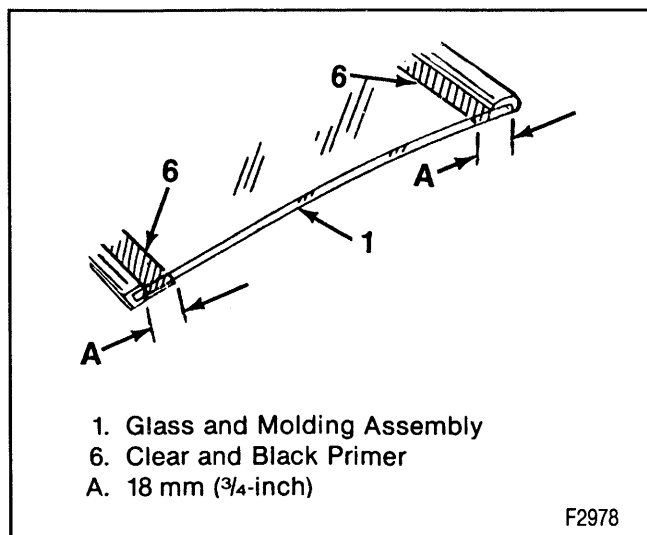


Figure 3—Windshield Primer Locations

Other materials required for windshield installation which are not included in the service kit include:

1. Alcohol for cleaning the edge of the glass.
2. Adhesive dispensing gun J 24811.
3. A standard household cartridge type gun reworked as follows:
 - A. Widen the end slot to fit the diameter of the dispensing nozzle of the adhesive tube.
 - B. Reduce the diameter of the plunger disc so that the disc will enter the large end of the adhesive tube.
4. Commercial type razor knife (for cutting along the edge of the glass).

NOTICE: Do not use a petroleum-based solvent such as kerosene or gasoline. The presence of oil will prevent adhesion of new material.

WINDSHIELD INSTALLATION

CAUTION: Always wear heavy gloves and safety glasses when handling glass to minimize the risk of injury.

→← Install or Connect (Figures 1, 3 and 4)

- If the original windshield is being reinstalled, clean all old urethane off the windshield using a razor knife.
 - Use GM repair kit P/N (12345633) or equivalent which contains the necessary primers and adhesives.
1. Clear primer to the windshield covering an area 18 mm (3/4 inch) from the glass edge. Wipe the primer dry immediately.
 2. Black primer to the same area as the clear primer and allow it to dry.

CAUTION: Refer to "Caution" on page 10A3-1.

3. Bead of urethane 10.0 mm (0.40 inches) high over the primer.

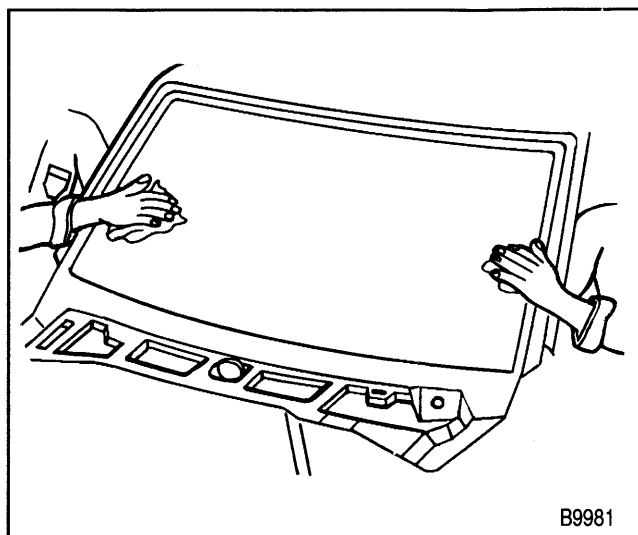


Figure 4—Glass Installation

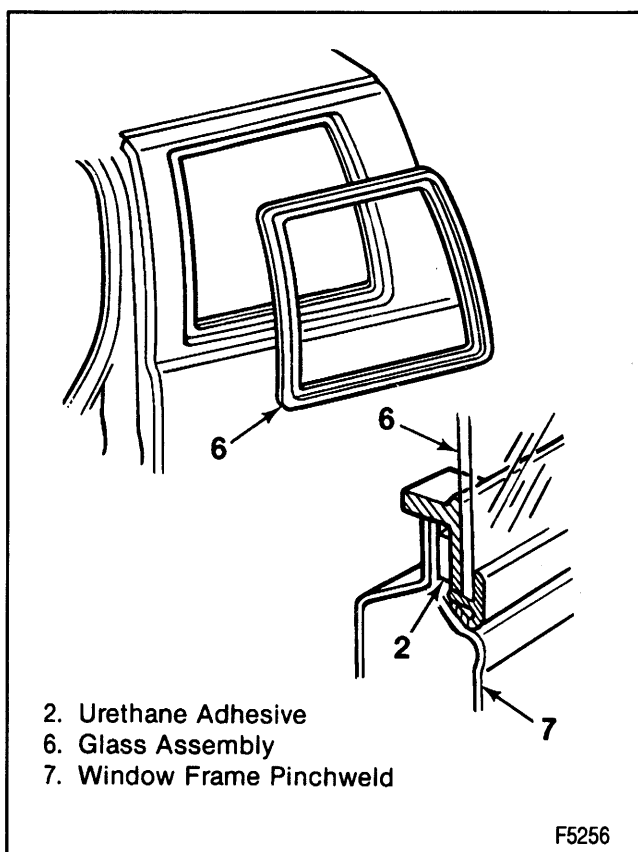


Figure 5—Extended Cab Stationary Body Side Glass

4. Windshield.
 - Drill or punch a hole in the center of each tab at the bottom of the windshield.
 - With the aid of a helper, lift the windshield into place.
 - Align the groove in each upper outer edge of the windshield molding with the door edge.
5. Windshield stop screws.
6. Rear view mirror.
7. Windshield pillar trim and door weatherstrip.
8. Speaker grilles.

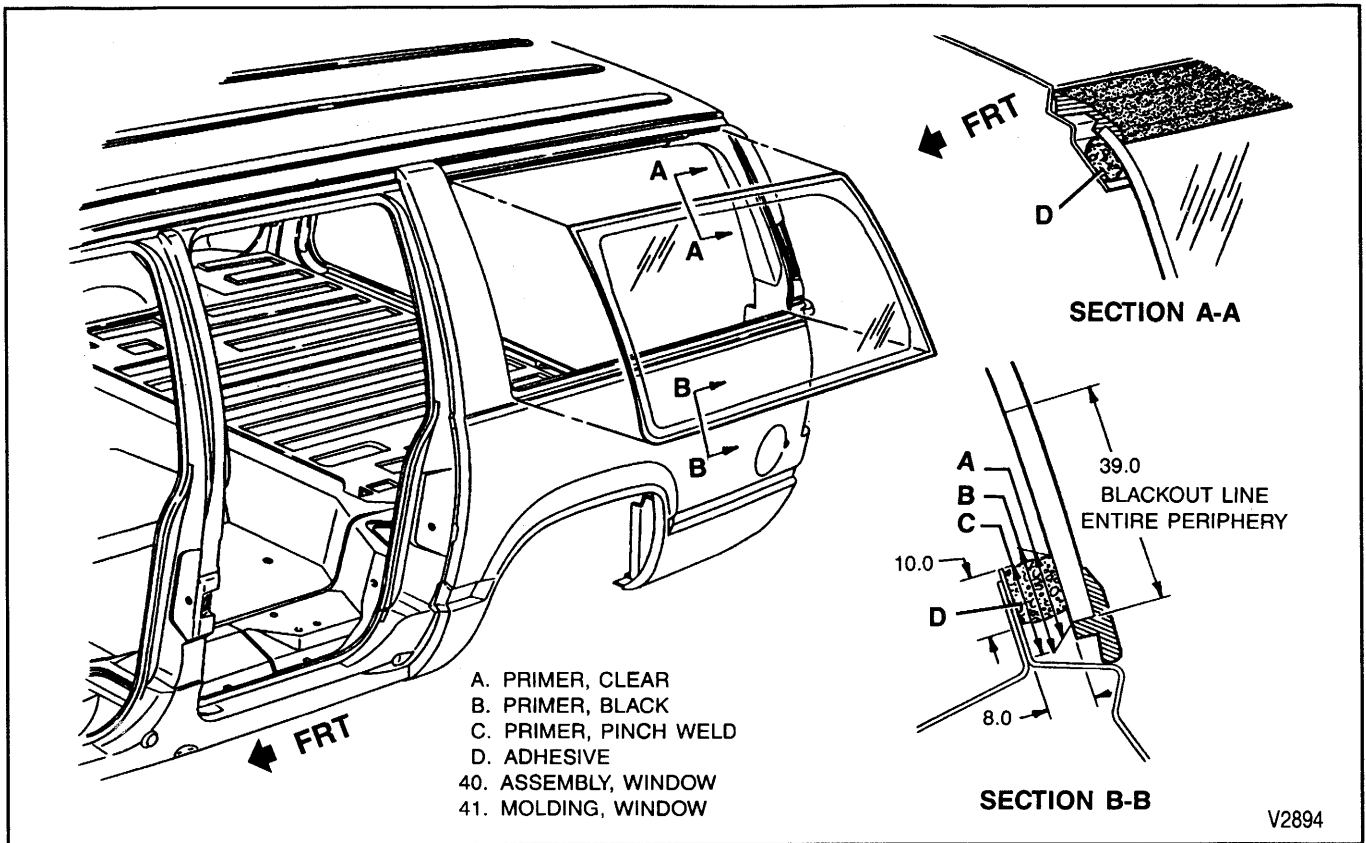


Figure 6—Stationary Body Side Glass

9. Cowl vent grille.
10. Windshield wiper arms.
11. Radio antenna mast.
12. Windshield garnish moldings.

NOTICE: Until the new urethane has cured, air pressure from a closing door may cause the windshield to move. To prevent this, lower one window several inches before closing the door.

- Allow the vehicle to stand for several hours for the adhesive to dry.
- Test the windshield for water leaks. Refer to "Water Leak Tests."

STATIONARY BODY SIDE WINDOW REPLACEMENT

CAUTION: Always wear heavy gloves and safety glasses when handling glass to minimize the risk of injury.

Remove or Disconnect (Figures 5 and 6)

Tools Required:
J-24709-01, Urethane Glass Sealant Remover—Hot Knife.
J-24402-A, Glass Sealant Remover Knife.

1. Quarter trim panel from around the window frame. Refer to SECTION 10A4.
2. Molding from the glass with a razor knife.

3. Window glass assembly using J-24709-01 or J-24402-A.

- Wipe away loose adhesive from the frame with a dry cloth.

Install or Connect (Figures 5, 6, and 7)

1. Body primer on the pinchweld flange in areas where the paint has come off.
 - Use the GM repair kit, P/N (12345633), or equivalent, which contains the proper primers and adhesive.
 - Allow the primer to dry.
2. Clear primer to the window covering an area of 18 mm (3/4 inch) from the edge of the glass (figure 6 and 7).
 - Wipe primer dry Immediately.
3. Black primer to the same area as the clear primer.
 - Allow the primer to dry.

CAUTION: Refer to "Caution" on page 10A3-1.

4. Urethane adhesive bead to the body to fill in any gaps in the old adhesive.
 - Apply a light hand pressure to the glass to wet-out the adhesive and to bond the glass to the pinchweld.
5. Quarter trim panel. Refer to SECTION 10A4.
 - Allow the adhesive to dry for several hours and then test the window for water leaks. Refer to "Water Leak Test."

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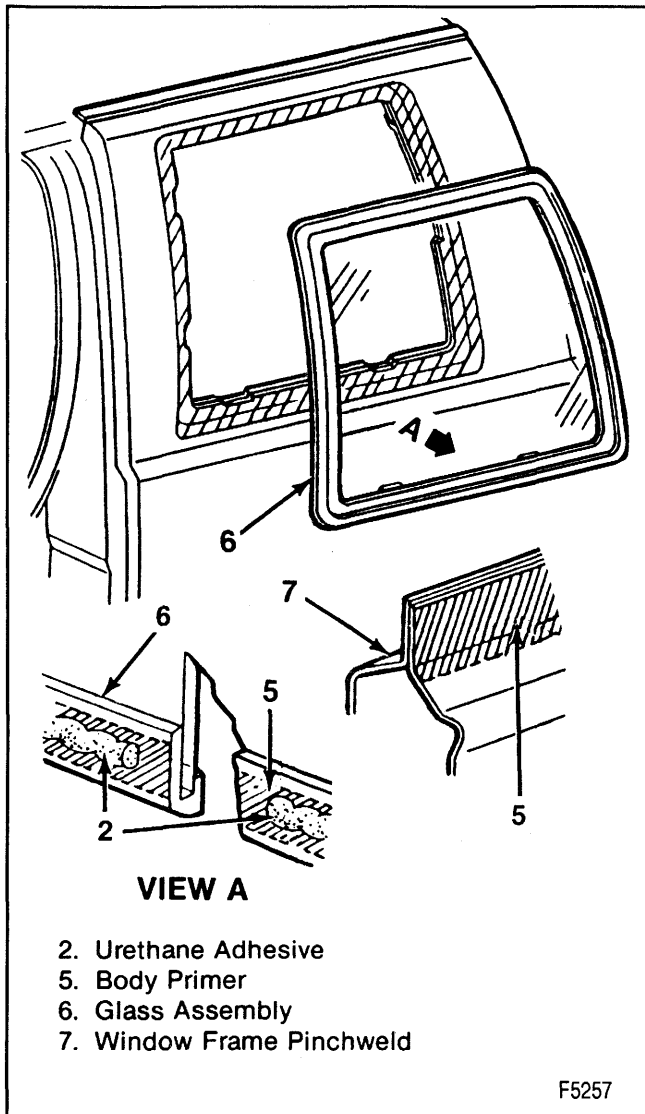


Figure 7—Primer and Adhesive Application Points

BODY SIDE LATCHED WINDOW REPLACEMENT

The latched side window is a one-piece assembly that includes the window, molding, hinges, and latch assembly.

Remove or Disconnect (Figures 8 and 9)

1. Latch rivets.
2. Hinge rivets.
3. Window assembly.

- Do not replace the weatherstrip unless it is damaged.

Install or Connect (Figures 8 and 9)

1. Window assembly.
2. Hinge rivets.
3. Latch rivets.

REAR WINDOW REPLACEMENT

Remove or Disconnect (Figure 10, 11 and 12)

CAUTION: Always wear heavy gloves and safety glasses when handling glass to minimize the risk of injury.

NOTICE: If a glass is cracked but still intact, it should be crisscrossed with masking tape to reduce the risk of damage to the vehicle.

- On a window with a defogger, unclip the connector at the left and right side of the window from the inside of the cab.
- Remove all trim panels necessary to gain access for rear window removal. Refer to SECTION 10A4 for the trim panel removal procedures.

1. Molding from the glass with a razor knife.
2. Glass assembly from the window frame using J-24709-01 or J-24402-A.

- With a helper standing outside the cab, push the window out from the inside.
- Wipe away the loose adhesive from the frame with a dry cloth.

Install or Connect (Figure 10, 11, and 12)

1. Body primer to the pinchweld flange in areas where the paint has come off.
 - Use the GM repair kit P/N (12345633) or equivalent that contains the proper primers and adhesive.
 - Allow the primer to dry.
2. Clear primer to the window covering an area of 18 mm (3/4 inch) from the edge of the glass.
 - Wipe off immediately.
3. Black primer to the same area as the clear primer.
 - Allow the primer to dry.

CAUTION: Refer to "Caution" on page 10A3-1.

4. Urethane adhesive bead to the body to fill in any gaps in the old adhesive.
5. Window.
 - On windows with defoggers, connect the clips on each side of the window on the inside to the body connectors.
 - Install all trim panels that were removed to gain access for rear window removal.
 - On sliding windows, be sure the two tabs on the bottom of the window are positioned in the slots on the body before installing the window.

REAR WINDOW DEFOGGER SYSTEM

The optional defogger consists of a heating element bonded to the inside surface of the rear glass. This unit uses an instrument panel mounted switch with an integral indicator lamp and will operate for 5 to 10 minutes and will then turn off by automatic timer. The system can be turned off during this operating period by manually shutting off the defogger switch or turning off the ignition switch. When activated, an indicator light is illuminated. A 12-volt current flows through the relay and

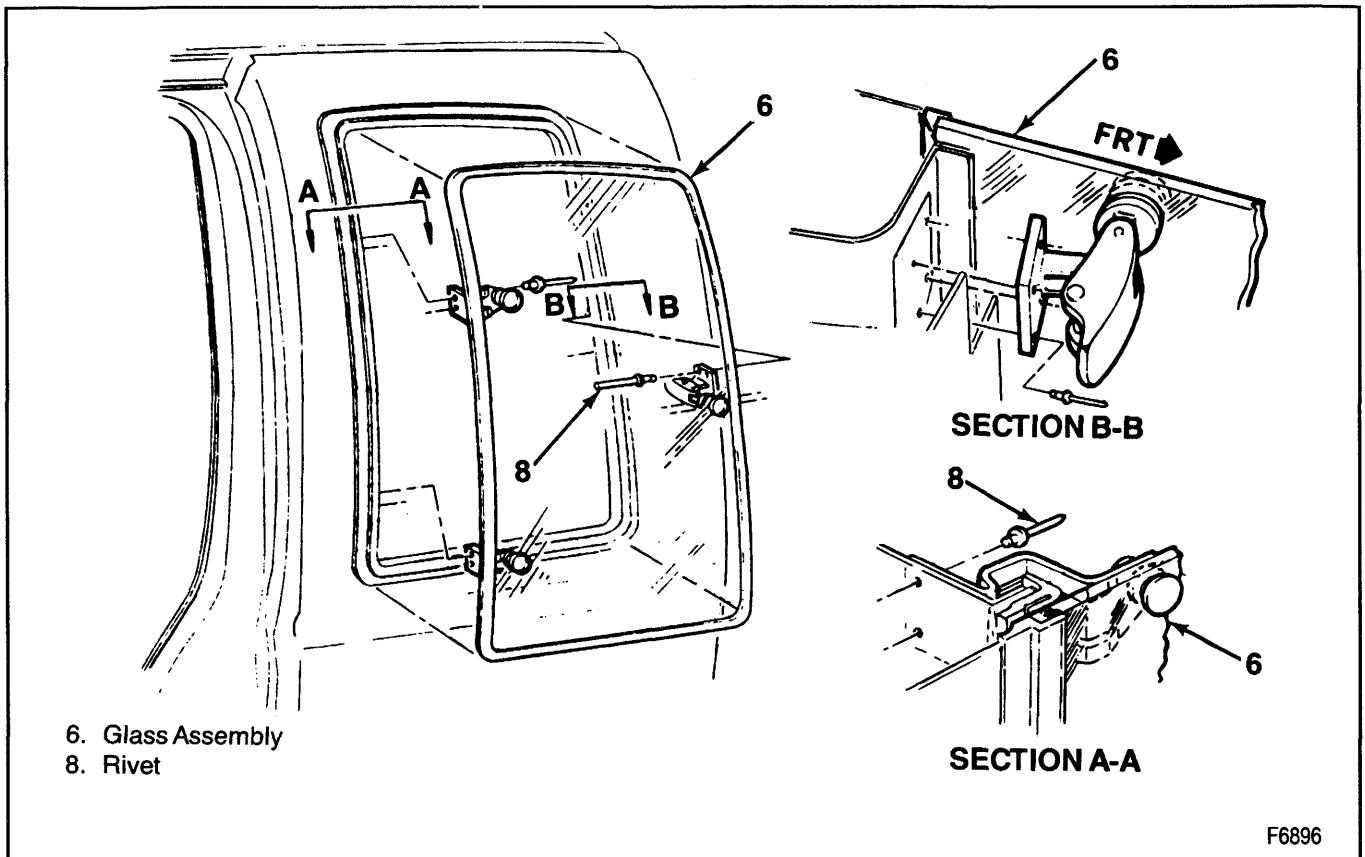


Figure 8—Body Side Latched Window Components

out to the resistive heating elements on the rear window. The current enters the grid from the left side of the window and leaves the grid heater from the right side of the window. The ground circuit is on the right side of the cab.

The length of time required to remove interior fog varies under such conditions as vehicle speed, outside

glass temperature, atmospheric pressure, and number of passengers.

The rear window harness plugs into connector at the fuse panel and leads to the instrument panel mounted switch. The harness then continues from the switch routed along the left rocker panel area to the rear of the cab. At this point it is routed up to where it meets the grid connector at the back glass.

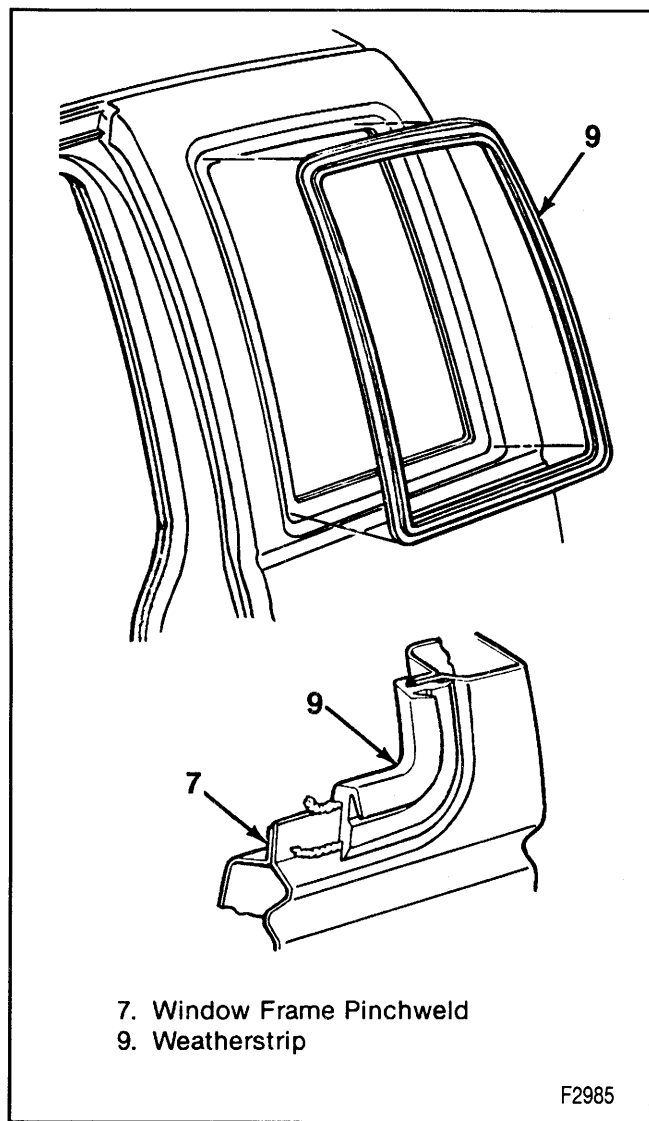


Figure 9—Side Latched Window Weatherstrip

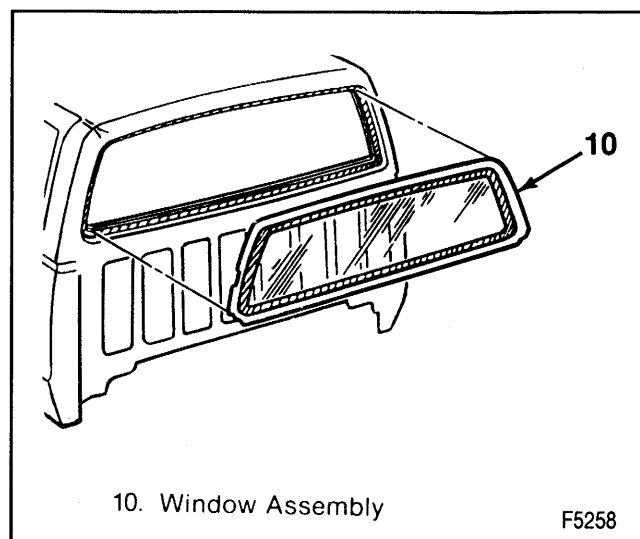


Figure 10—Rear Window Assembly Pickup

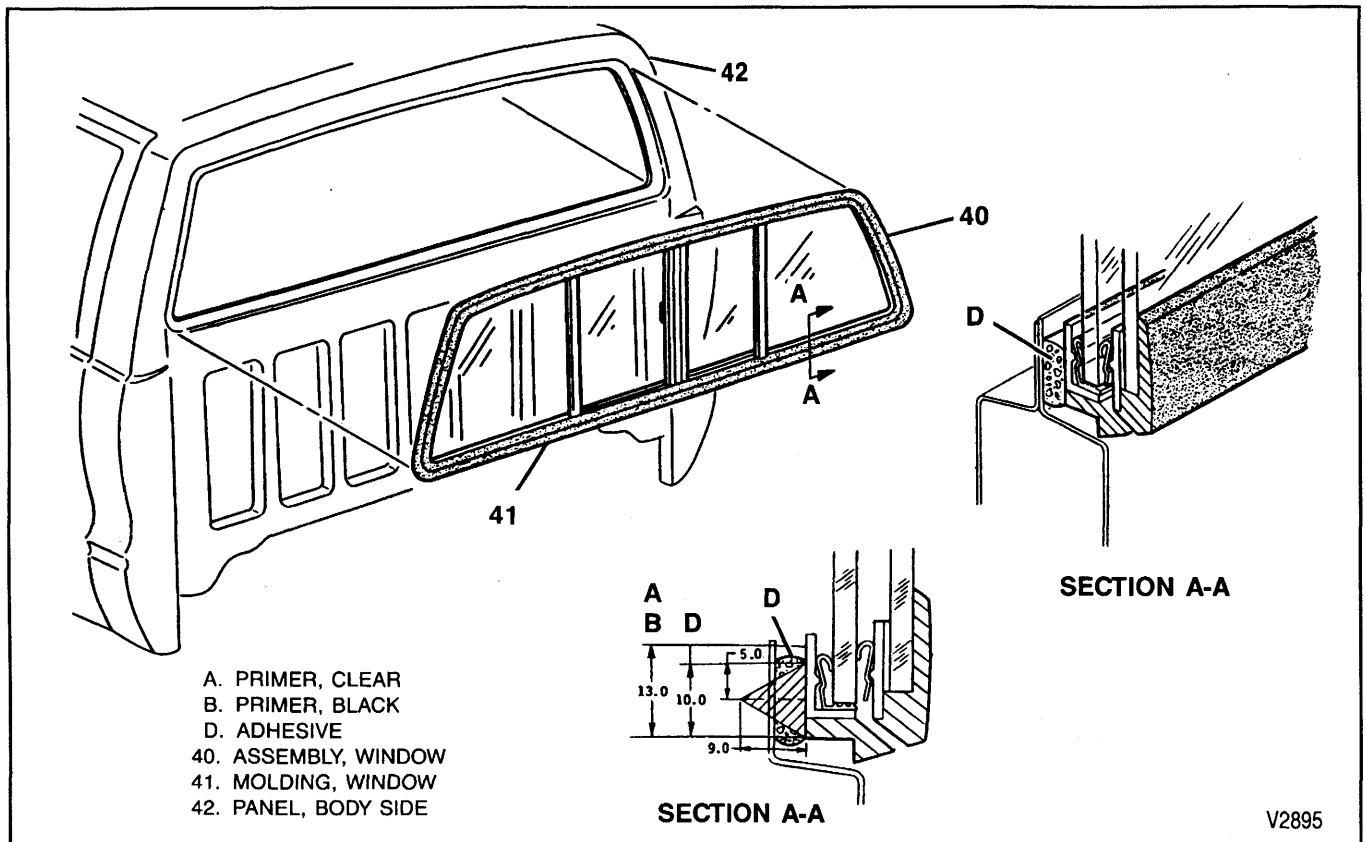


Figure 11—Rear Sliding Glass Window Assembly-Pickup

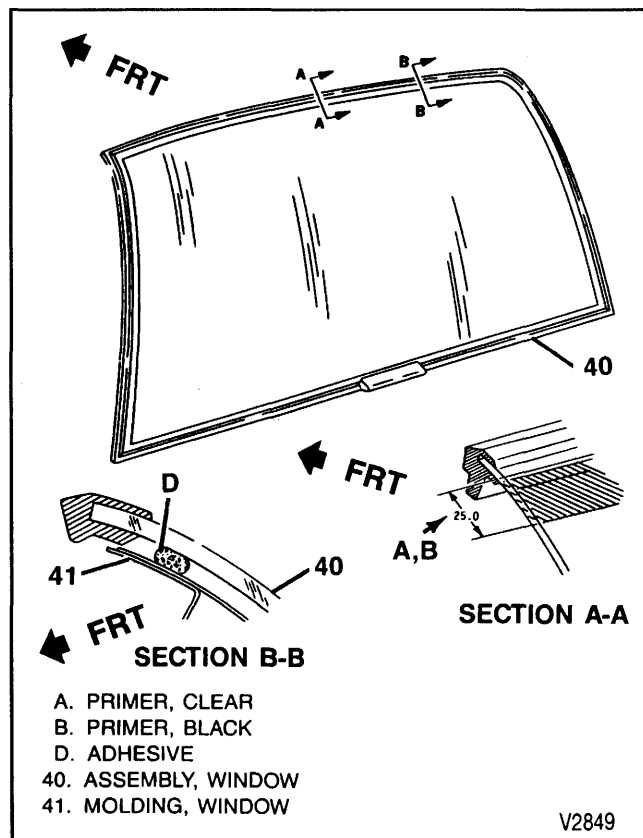


Figure 12—Rear Window Assembly Suburban and Utility

DIAGNOSIS OF THE REAR WINDOW DEFOGGER SYSTEM

PROBLEM	POSSIBLE CAUSE	CORRECTION
System Won't Heat The Window	1. Blown fuse. 2. Broken switch. 3. Circuit is open.	1. Replace the fuse with a fuse of the correct rating. 2. Test the switch for conduction. Replace the switch if necessary. 3. Test for voltage at the left connection of the window. If voltage is present, check the ground circuit. If voltage is not present, test the relay for operation and voltage. If the relay voltage is present, find the open in the harness between the relay and the heater.
System Won't Turn On. The Indicator Lamp Is Off.	1. Blown rear window defogger fuse. 2. Relay is faulty. 3. Switch is faulty.	1. Replace the fuse with a fuse of the correct rating. 2. Make sure the relay is firmly seated in its socket. Jump the ORN/BLK wire to the LT BLU wire. The relay should click. If the relay clicks, find the open between the switch and the relay if the relay doesn't click, replace the relay. 3. Test the switch with a test lamp. Replace the switch with a test lamp. Replace the switch if it's proven faulty.

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TESTING REAR WINDOW DEFOGGER GRID LINES

1. Start the engine and turn on the defogger system.
2. Ground an unpowered test lamp and lightly touch the prod tip to each grid line.

- Move the lamp from the feed wire side to the grounded side of each grid. The lamp should be fully bright then gradually dim as it is moved across the grid. Be sure to check each grid line in at least two places to avoid the possibility of bridging a gap (figure 13).

3. If the test lamp shows full brilliance at both ends of the grid line, check for a loose ground wire connection to the sheet metal.
4. If the lamp suddenly goes out as it is moved across the grid, a break has been located.

GRID LINE REPAIR

Tools Required:

Rear Window Defogger Repair Kit (P/N 12345345)

Heat Gun - capable of reaching 260° C (500° F)



Remove or Disconnect

Negative battery cable(s). Refer to SECTION 0A.



Inspect

Rear window defog lines. (Mark the grid line breaks on the outside of the window with a grease pencil).



Clean

The grid line area to be repaired. Buff with steel wool and wipe clean using a cloth dampened with alcohol. Buff and clean about 6 mm (0.25 in.) beyond each side of the break in the grid line. Be sure the glass is at room temperature.



Install or Connect

1. Grid line repair template or two strips of tape positioned above and below the repair area. Repair template or tape **MUST** be used to control the width of the repair area. If the template is used, be sure the die cut metering slot is the same width as the grid line.

CAUTION: Keep the repair material away from heat, sparks or open flame, since the material is flammable. Avoid breathing the vapor, or allowing it to contact skin or eyes, since it can cause irritation.

2. The grid repair material at room temperature to the repair area using a small brush (figure 14).

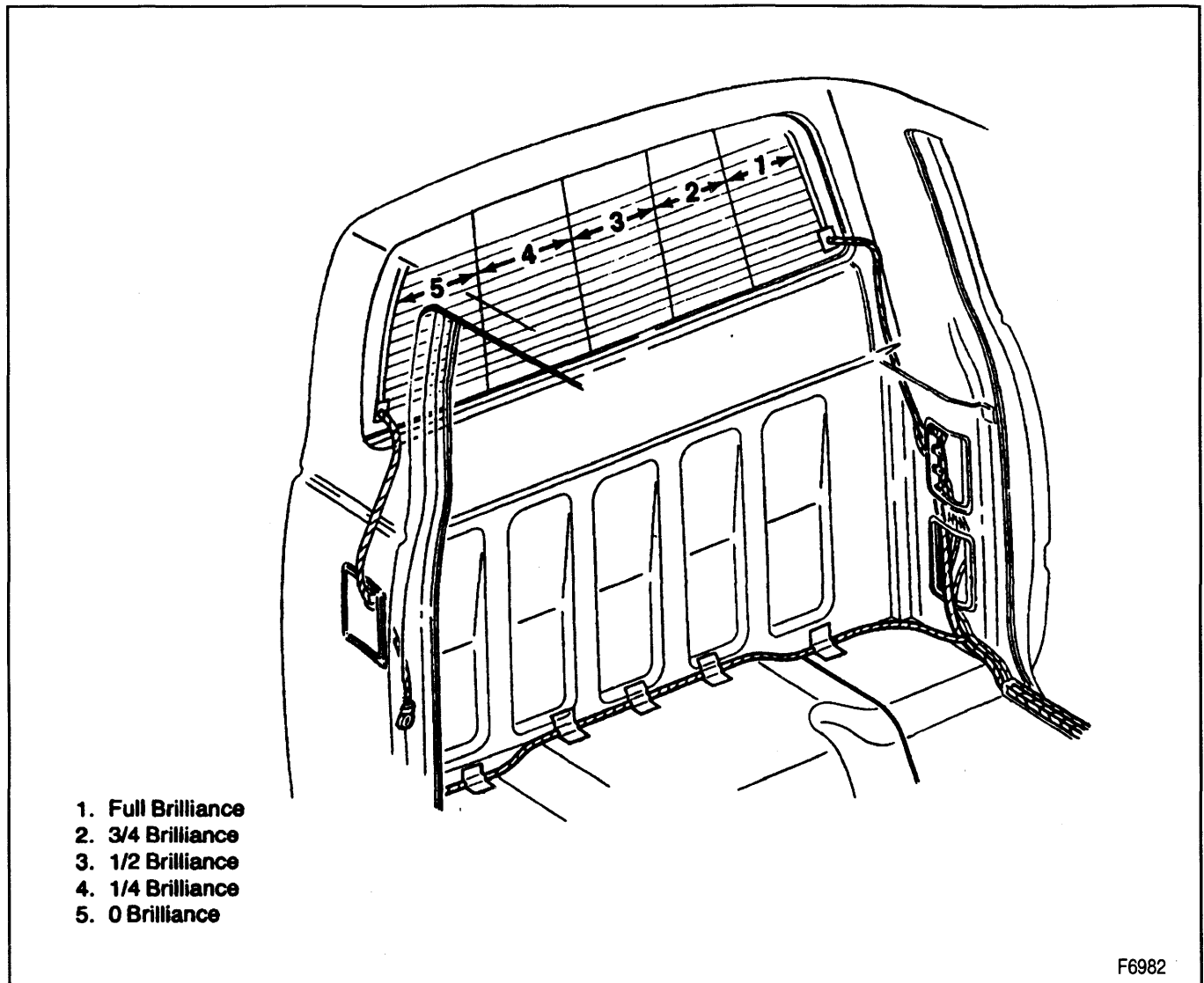


Figure 13—Test Lamp Brilliance Zones - Normal Operating Rear Window

3. Remove the template or tape carefully.

NOTICE: The grid line repair material must be cured with heat. To avoid heat damage to the interior trim, protect the trim near the repair where heat is applied.

4. Holding the heat gun 25 to 50 mm (1 to 2 inches) from the repair area, apply heat at 260° - 370° C (500° to 700° F) for 2 to 3 minutes (figure 15). If a heat gun is not available, allow the repair to air dry at an ambient temperature of 20° to 39° C (70° to 90° F) for 24 hours.
5. Negative battery cable(s).



Inspect

1. Grid line repair area. If the repair appears discolored, apply a coat of tincture of iodine to the repair area using a pipe cleaner or a fine brush. Allow iodine to dry for about 30 seconds and carefully wipe off the excess with a lint-free cloth.

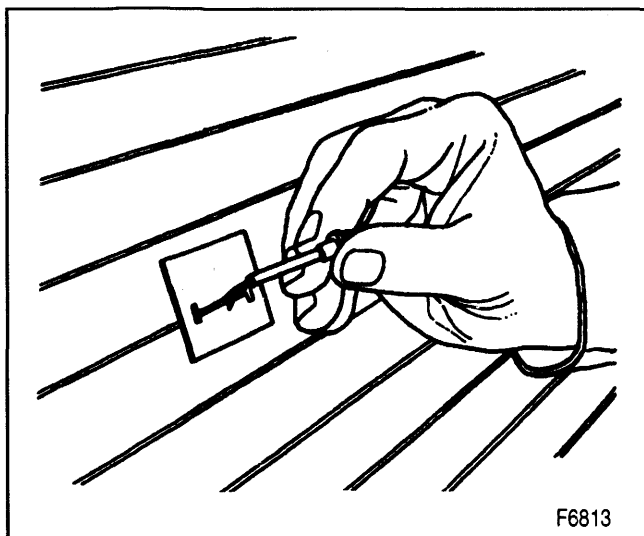


Figure 14—Apply Grid Material to a Broken Grid Line

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2. Test the defogger operation to verify grid line repair.
3. Leave the grid area untouched for 24 hours.

BRAIDED LEAD WIRE REPAIR

1. The rear defogger bus bar lead wire or terminal can be reattached by soldering using a solder containing 3 percent silver and a rosin flux paste.
2. Before soldering the bus bar, the repair area should be buffed with fine steel wool. This removes the oxide coating formed during the glass manufacture.
3. Apply the paste-type rosin flux in small quantities to the wire lead and bus bar repair area using a brush.
4. The soldering iron tip should be coated with solder beforehand. Use only enough heat to melt the solder and only enough solder to ensure a complete repair.
5. Do not overheat the wire when resoldering it to the bus bar.

WINDOW POLISHING

MINOR SCRATCH AND ABRASION REMOVAL

Minor scratches and abrasions can be removed or reduced by following the procedure outlined below. Precautions must be taken to prevent distortions of vision. Double vision may result if an attempt is made to remove deep scratches. Deep scratches should not be removed from an area in the driver's line of vision; in such cases, the glass should be replaced.

The procedure that follows was developed using a cerium oxide compound. Follow manufacturer's directions if other materials are used.

Recommended Equipment

1. A low speed (600-1300 rpm) rotary polisher.
2. A wool felt, rotary polishing pad 7 mm (three inches) in diameter and 51-mm (2 inches) thick.

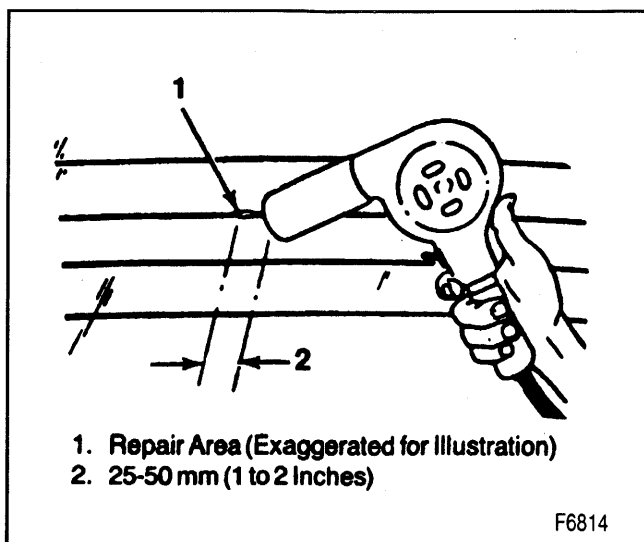


Figure 15—Applying Heat to the Grid Line Repair

3. Powdered cerium oxide mixed with water. This is the abrasive compound.
4. A wide mouth container to hold the abrasive compound.

Polishing Procedure (Figure 16)

1. Mix at least 44 ml (1.5 oz.) of cerium oxide with enough water to obtain a creamy consistency. (If the mixture is too thick it will cake on the felt pad more quickly. If it is too runny, more polishing time will be needed.)
2. Draw a circle around the scratches on the opposite side of the glass with a marking crayon or equivalent.
3. Draw a line directly behind the scratch(es) to serve as a guide for locating the scratch while polishing.
4. Cover the surrounding area with masking paper to catch the drippings or spattered polish.
5. Dip the felt pad attached to the polisher into the mixture. Do not submerge the pad or allow the pad to stay in the mixture as it may loosen the bond between the pad and the metal plate.

NOTICE: Never hold the tool in one spot or operate the tool on the glass any longer than 30 to 45 seconds. If the glass becomes hot to touch, let it air cool before proceeding further. Cooling with cold water may crack heated glass. Avoid excessive pressure. It may cause overheating of the glass.

6. Polish the scratched area, but note the following:
 - Agitate the mixture as often as needed to maintain the creamy consistency of the compound.
 - Use moderate but steady pressure.
 - Hold the pad flat against the glass.
 - Use a feathering-out motion.
 - Dip the pad into the mixture every 15 seconds to ensure that the wheel and the glass are always wet during the polishing operation. (A dry pad causes excessive heat to develop.)
 - Keep the pad free of dirt and other foreign substances.

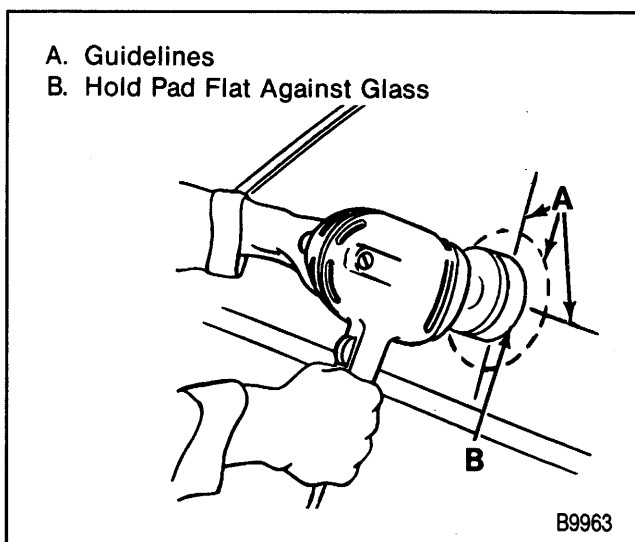


Figure 16—Window Polishing

WATER LEAK TESTS

Various methods can be used to check for water leaks after the window adhesive has been allowed to dry. Use the first test method whenever possible for generalized testing since it provides a large volume of water to a general area without exceeding the sealing limitations of the glass. Once the leak area has been found, locate the exact entry point by using the water hose or air hose test.

CHECKING WITH WATERTEST STANDS

To assemble watertest stands, refer to figure 17. Use them as follows.

1. Position the stands as shown in figures 18 and 19. Water spray from the stands should overlap on the vehicle.
2. Run the water at a volume of 14 liters (3.7 gallons) per minute and at a pressure of 155 kPa (22 psi) (measured at the nozzle) for at least 4 minutes.
3. Have someone inside the cab during the test to check for the location of any leaks.
4. To check the windshield, the water spray should be aimed 30 degrees down and 45 degrees toward the rear. Aim at the corner of the windshield (figure 19).
5. To check the side windows, the water spray should be aimed 30 degrees down and 45 degrees toward the rear. Aim at the center of the rear quarter.
6. To check the back window, aim the water spray 30 degrees down and 30 degrees toward the front.

WATER HOSE TEST

Run water through a hose without the nozzle attached. Begin testing at the base of the window or windshield and slowly move the hose upward and across the top. Have someone in the vehicle watch for leaks.

AIR HOSE/BUBBLE SOLUTION TEST

Put liquid detergent diluted with water in a squirt bottle. Have a helper inside the cab with an air hose. Beginning at the bottom of the window and gradually moving up the window edges and across the top, squirt soap solution on the window moldings and glass on the outside of the vehicle. Have a helper aim the compressed air at the same locations from the inside of the vehicle. Air pressure from the hose should not exceed 205 kPa (30 psi). Bubbles will form in the soap solution at the location of the leak.

WINDSHIELD WATER LEAK REPAIR

Depending on where the leak is located, it may be necessary to remove trim molding or the headliner to repair the leak. Refer to SECTION 10A4 for removal procedures.

1. Determine the source of water entry.

CAUTION: Refer to "Caution" on page 10A3-1.

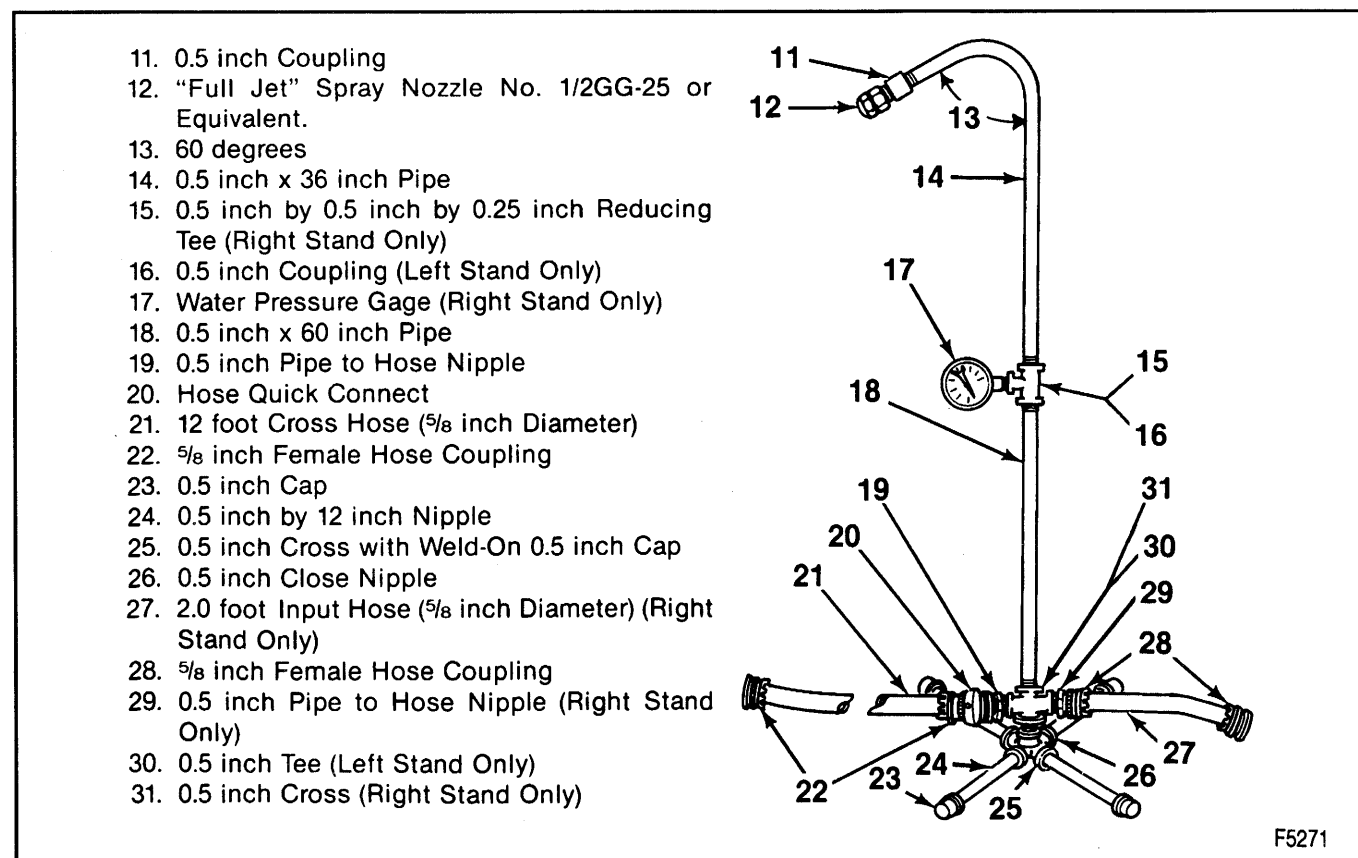


Figure 17—Watertest Stand Assembly

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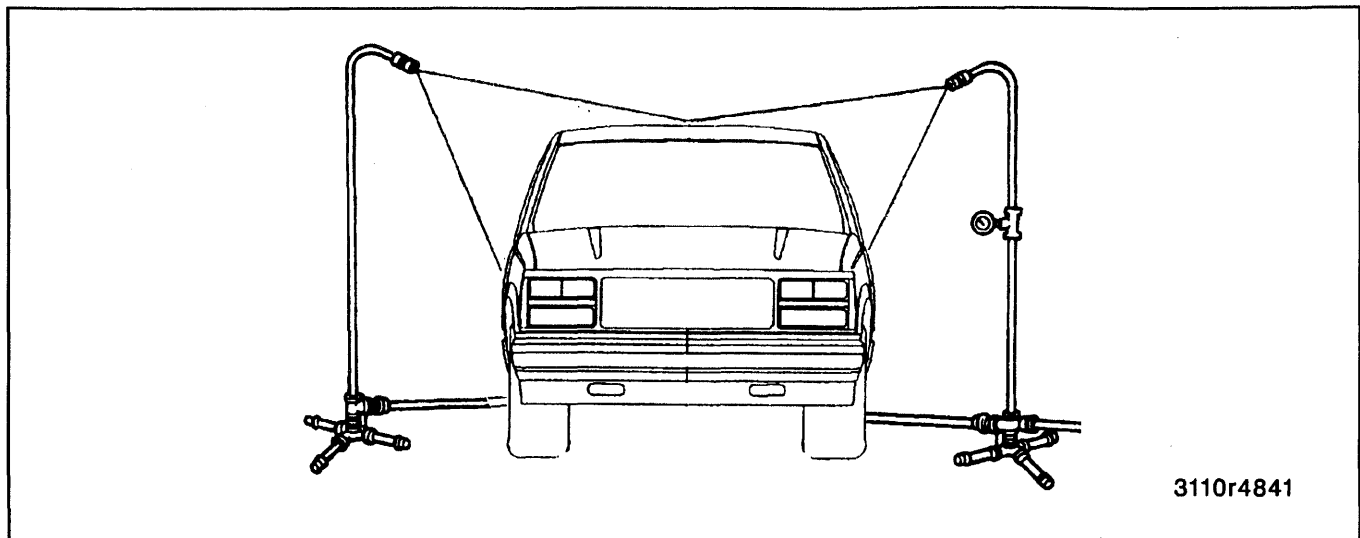


Figure 18—Water Leak Test Stands

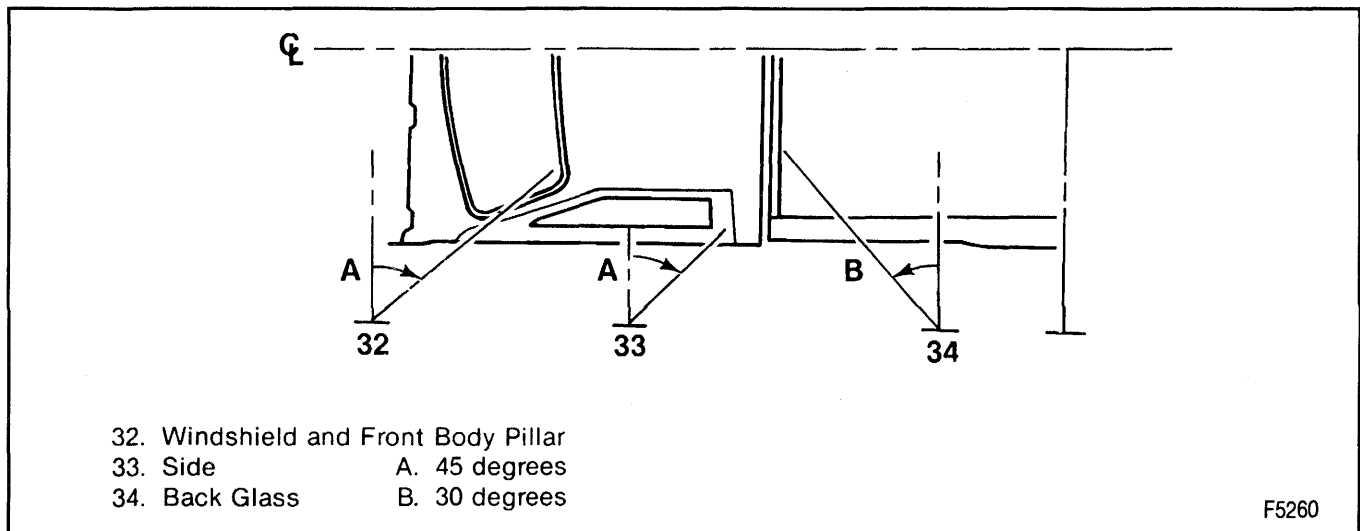
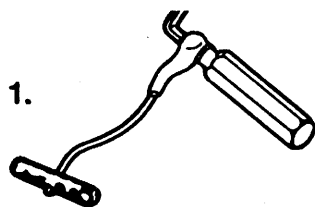


Figure 19—Water Leak Test with Test Stands

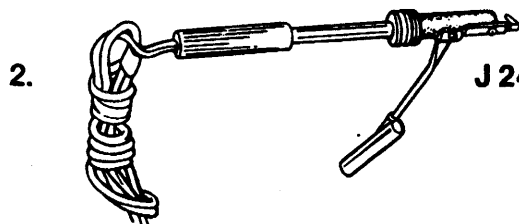
2. If water is leaking at the edge of the windshield, reseal it using "Windo-Weld Resealant" P/N 08633 and applicator gun 3M 08992 or equivalent. Use a "duck bill" applicator tip to inject the sealant under the molded glass seal.

3. If water is leaking into the vehicle at the sides of the glass use 3M "Super Fast" urethane auto glass sealant P/N 08609 or equivalent.

SPECIAL TOOLS

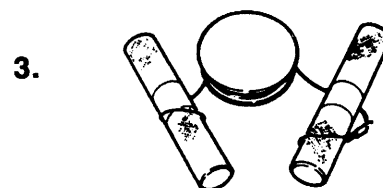


J 24402-A



J 24709-01

1. Glass Sealant Removal Knife
2. Urethane Glass Sealant Remover
3. Allante Windshield Remover



J 36020

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NOTES

SECTION 10A4

INTERIOR TRIM

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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ON-VEHICLE SERVICE

HANDLING ELECTROSTATIC DISCHARGE (ESD) SENSITIVE PARTS

Many solid state electrical components, such as those found in the instrument panel and the radio, can be damaged by electrostatic discharge (ESD). Some will display a label, but many will not (figure 1).

NOTICE: In order to avoid possibly damaging any components, observe the following:

1. Body movement produces an electrostatic charge. To discharge personal static electricity, touch a ground point (metal) on the vehicle. This should be done any time you:
 - Slide across the car seat.
 - Sit down or get up.
 - Do any walking.
2. Do not touch exposed electric terminals on components with your finger or any tools. Remember, the connector that you are checking might be tied into a circuit that could be damaged by electrostatic

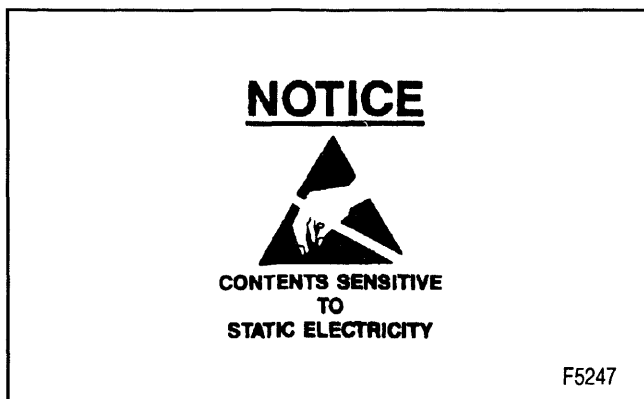


Figure 1—Electrostatic Discharge Parts Symbol

discharge.

3. When using a screwdriver or similar tool to disconnect a connector, never let the tool come in contact with or come between the exposed terminals.
4. Never jump, ground, or use test equipment probes on any components or connectors unless specified in diagnosis. When using test equipment, always connect the ground lead first.
5. Do not remove the solid state component from its protective packaging until you are ready to install the part.
6. Always touch the solid state component's package to a ground before opening. Solid state components can also be damaged if:
 - They are bumped or dropped.
 - They are laid on any metal work benches or components that operate electrically, such as a TV, radio, or oscilloscope.

INSTRUMENT PANEL AND CARRIER ASSEMBLY REPLACEMENT

The instrument panel carrier is designed not only to access parts through removal of carrier components, but the carrier will also tilt down as a complete assembly to allow access from the top. Remove the retainer screws along the dash pad by the windshield. They are found under the speaker covers and along the defroster duct. The instrument panel will then tilt as an assembly into the cab. It is necessary to lower the steering column from the carrier to allow maximum movement of the instrument panel.



Remove or Disconnect (Figures 2 through 6)

1. Negative battery cable(s). Refer to SECTION 0A.
 - Pry out the stop cable retainer for the compartment door (figure 3).
2. Center accessory plate next to the compartment door, by lifting from the bottom.
3. Bolt attaching the lower left compartment door to the carrier.
4. Compartment door.
5. Four bolts holding the compartment to the carrier.
6. Compartment.
 - Open the ash tray assembly (figure 4).
7. Screws holding the tray to the carrier.
8. Tray assembly from the vehicle.

9. Wiring connector from the back of the assembly.
10. Four screws holding the bezel to the instrument panel carrier (figure 4).
11. Bezel from the instrument panel.
12. Headlamp switch connector.
13. Cargo lamp connector (if present).
14. Radio control.
15. Four screws retaining the heater control.
16. Wiring connector behind the heater control.
17. Heater control (figure 2).
18. Two screws retaining the steering column filler panel (figure 2).
19. Filler panel.
20. Shift indicator cable from behind the instrument cluster.
21. Instrument cluster. Refer to SECTION 8C.
22. Air duct and two bolts (figure 2).
23. Bolts retaining the instrument panel pod and trim.
24. Pod and trim (figure 3).
25. Lower trim panels (figure 3).
26. Speaker covers by prying up.
27. Five upper carrier screws.
 - One from under each speaker cover.
 - Three in the defroster vent grille.
28. Parking brake handle and cable from the ratchet assembly.
29. Two bolts retaining the hood release handle
30. Hood release handle.
31. Two screws retaining the data link connector under the left side of carrier.
32. Data link connector.
33. Door jamb switch.
34. Fuse box cover.
35. Screw holding the carrier to the instrument panel support.
36. Nut from each side of the steering column.
 - Lift the steering column from the support studs and lower it.
37. Left and right kick pads by prying them off.
38. Snap clips and bolts from the left and right bracket mounted studs, supporting the carrier (figure 5).
39. Lift off the carrier.
40. Wiring harnesses from the loom at the back of the carrier.
41. Connector to the instrument panel compartment lamp at the back of the carrier.
42. Five bolts holding the A/C duct to the carrier.
43. A/C duct (if present).
44. All wiring harnesses from behind the left side of the carrier.
45. Ground wire at the back of the carrier.
46. Carrier from the vehicle.



Install or Connect (Figures 2 through 6)

NOTICE: For steps 10, 12, 32, and 37, refer to "Notice" on page 10A4-1.

1. Carrier to the cab.
2. Wiring harness connectors to the back of the carrier.
3. Ground wire.
4. Two bolts retaining the wiring harnesses.

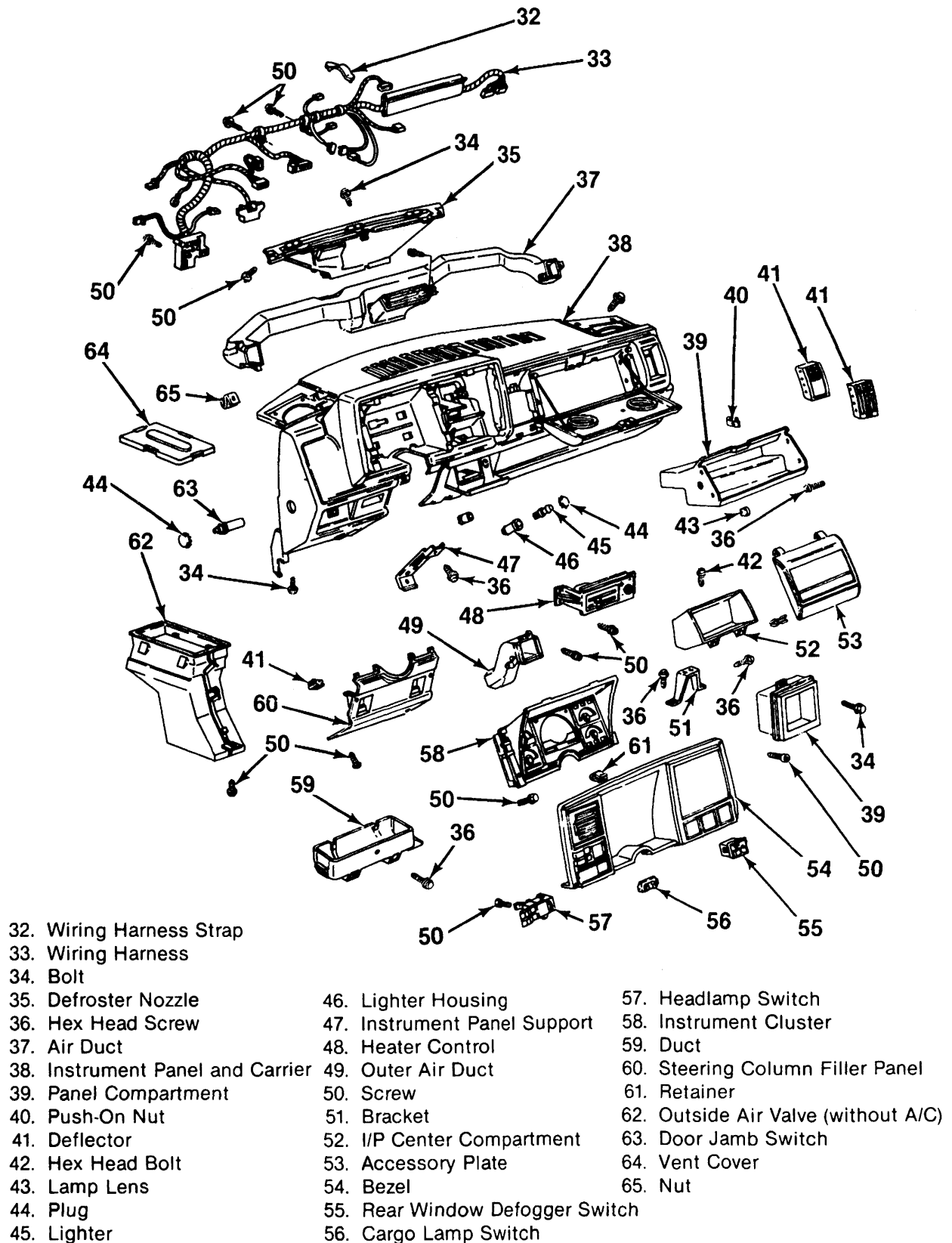


Figure 2—Instrument Panel and Carrier Assembly

10A4-4 INTERIOR TRIM

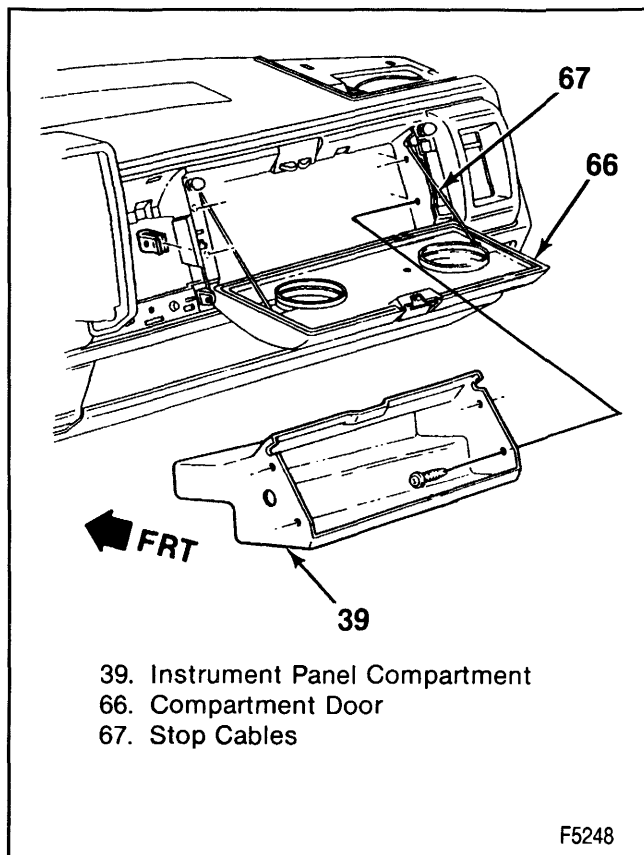


Figure 3—Instrument Panel Compartment

5. Door jamb switches to the right and left sides of the carrier.
6. A/C duct to the carrier with five bolts.
7. Connector to the instrument panel compartment lamp.
8. Wiring harness to loom.
9. Carrier brackets to body studs.
10. Bolts through body and carrier brackets.



Tighten

- Bolts to 20 N.m (15 lbs. ft.).

11. Clips over the body bracket studs.
12. Five upper carrier retaining screws.



Tighten

- Upper carrier screws to 1.9 N.m (17 lbs. in.).

13. Cover over the fuse box.
14. Hood release cable.
15. Data link connector.
16. Parking brake cable.
17. Carrier to instrument panel support.
18. Instrument panel pod and trim.
19. Retaining bolts.
20. Trim panels to the lower left and lower right of the pod.
21. Instrument cluster. Refer to SECTION 8C.
 - Lift the steering column onto the mounting studs.
22. Two nuts holding the column in place.

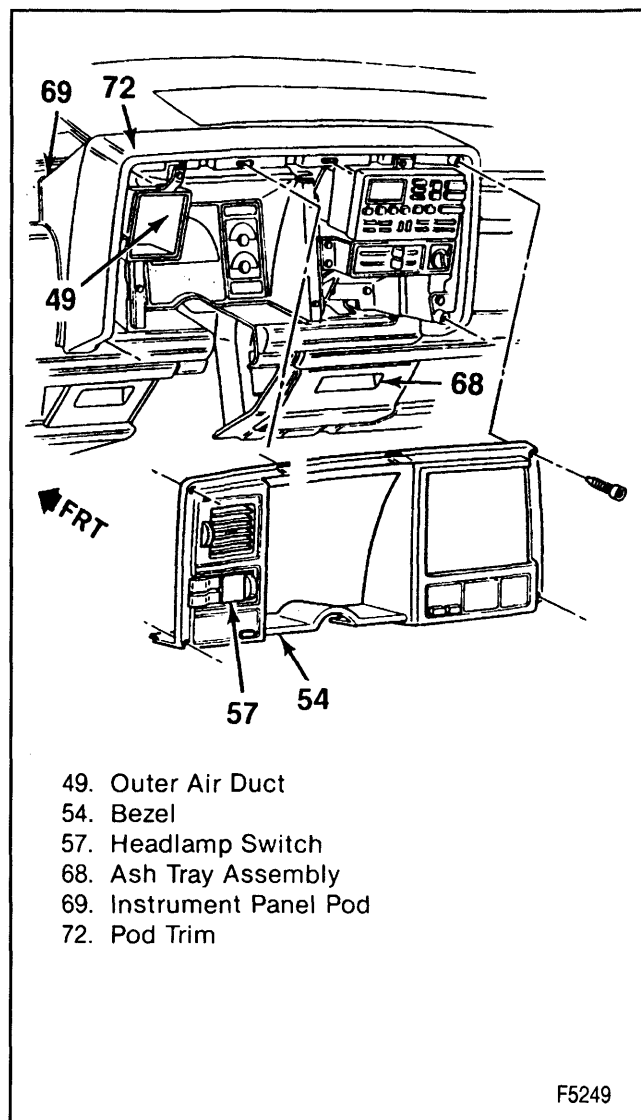


Figure 4—Instrument Panel Bezel

23. Shift indicator connector onto the steering column collar.



Adjust

- Cable indicator needle to correct gear.
24. Heater wiring harness to the heater control.
 25. Heater control to the carrier with four screws.
 26. A/C duct to the pad with screws.
 27. Speaker cover to the top of the carrier.
 28. Kick trim panels to the left and right sides of the cab.
 29. Radio controls.
 30. Cargo lamp connector to the switch (if present).
 31. Headlamp connector to the switch.
 32. Instrument cluster bezel on the carrier with four screws.



Tighten

- Bezel to carrier screws to 1.9 N.m (17 lbs. in.).
33. Steering column filler panel to the carrier.
 34. Ash tray assembly wiring connectors to the cigarette lighter and lamp (if present).

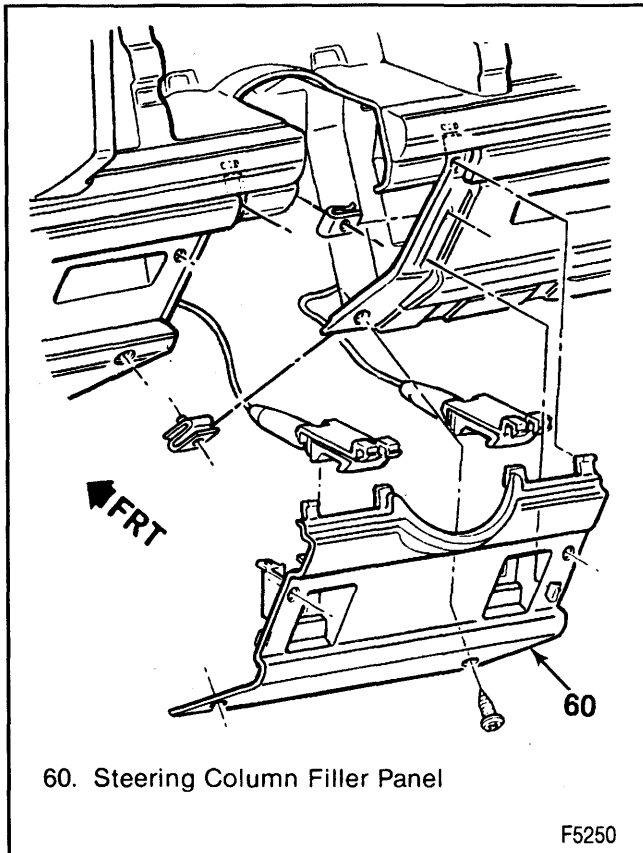


Figure 5—Steering Column Filler Panel

35. Strap around the wiring harness to the ash tray assembly.
36. Ashtray assembly to the carrier with four screws.
37. Instrument panel compartment to the right side of the carrier with four bolts.



Tighten

- Compartment to carrier bolts to 1.9 N·m (17 lbs. in.).

38. Compartment door to the carrier with one bolt.

39. Compartment door stop cables to the inside of the compartment.
40. Center accessory cover trim plate.
41. Negative battery cable(s).

CUP HOLDER REPLACEMENT



Remove or Disconnect (Figure 7)

1. Bolts from cup holder.
2. Cup holder from instrument panel.



Install or Connect (Figure 7)

1. Cup holder to instrument panel.
2. Bolts.



Tighten

- Bolts to 1.9 N·m (17 lbs. in.).

SUNSHADE REPLACEMENT



Remove or Disconnect (Figure 8)

1. Retaining screws.
2. Electrical connector if present.
3. Sunshade from roof panel.



Install or Connect (Figure 8)

1. Electrical connector if present.
2. Sunshade to roof panel.
3. Retaining screws.

ASSIST HANDLE REPLACEMENT



Remove or Disconnect (Figure 9)

1. Handle screw covers (9).
2. Screws.
3. Handle.

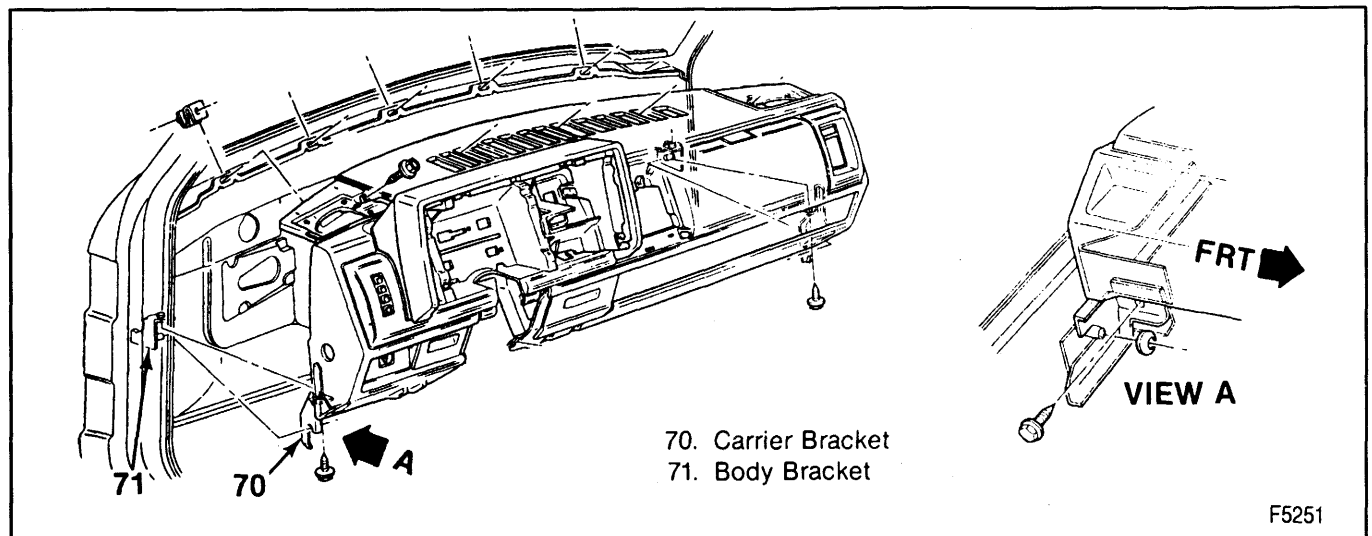


Figure 6—Carrier Bracket

10A4-6 INTERIOR TRIM

4. Spacers.

Install or Connect (Figure 9)

1. Spacers.
2. Handle.
3. Screws.
4. Handle screw covers.

COAT HOOK REPLACEMENT

Remove or Disconnect (Figure 10)

1. Screw from side rear panel.
2. Coat hook.

Install or Connect (Figure 10)

1. Coat hook to side rear panel.
2. Screw.

FRONT FLOOR COMPARTMENT REPLACEMENT

Remove or Disconnect (Figure 11)

1. Front tray from the compartment.
2. Storage bin.
3. Two plugs covering the screws.
4. Four screws.

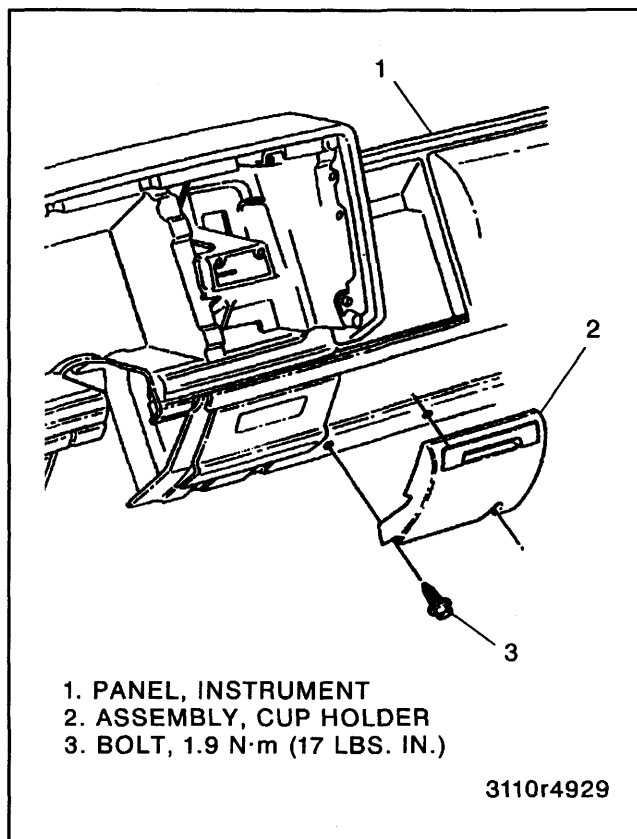


Figure 7—Cup Holder

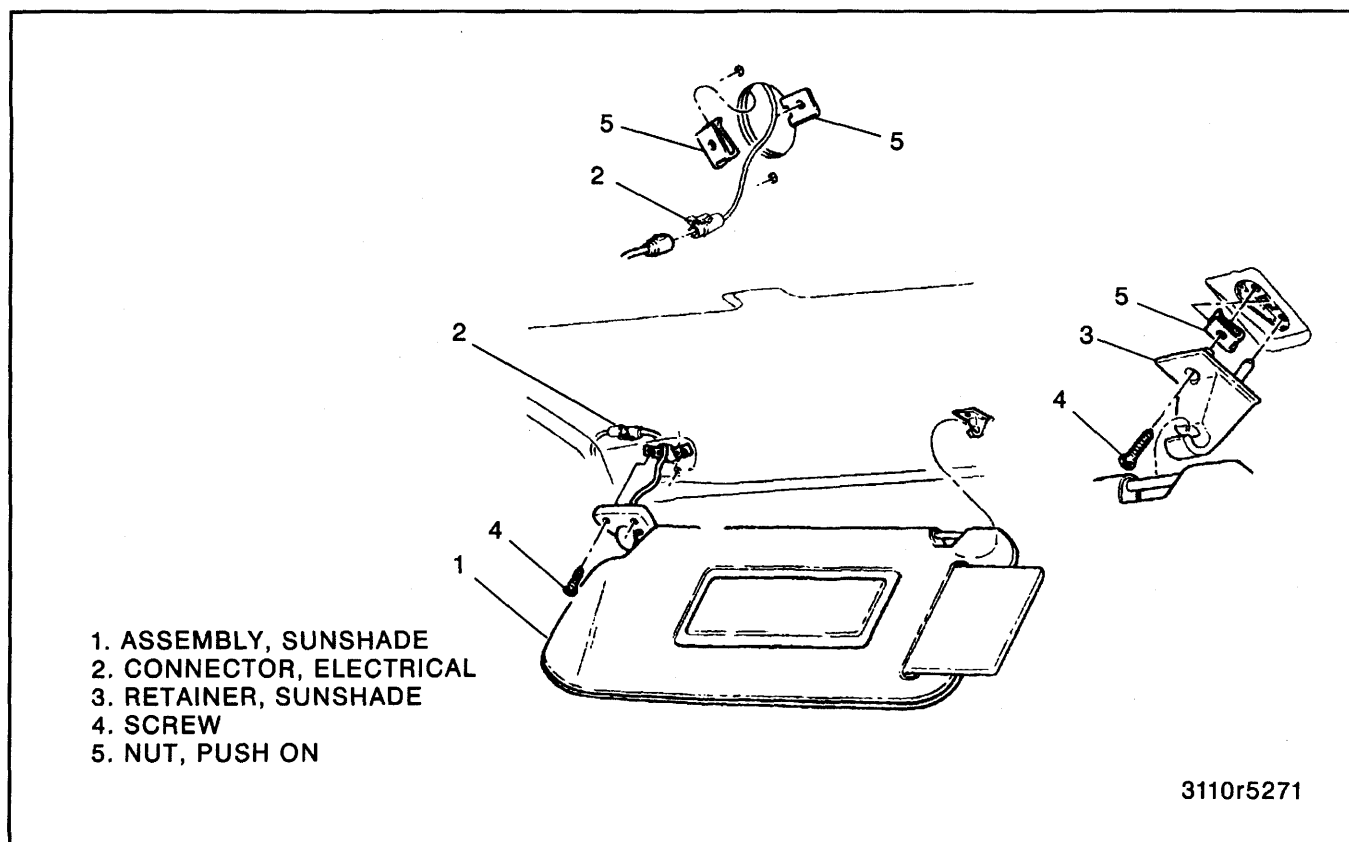


Figure 8—Sunshade Replacement

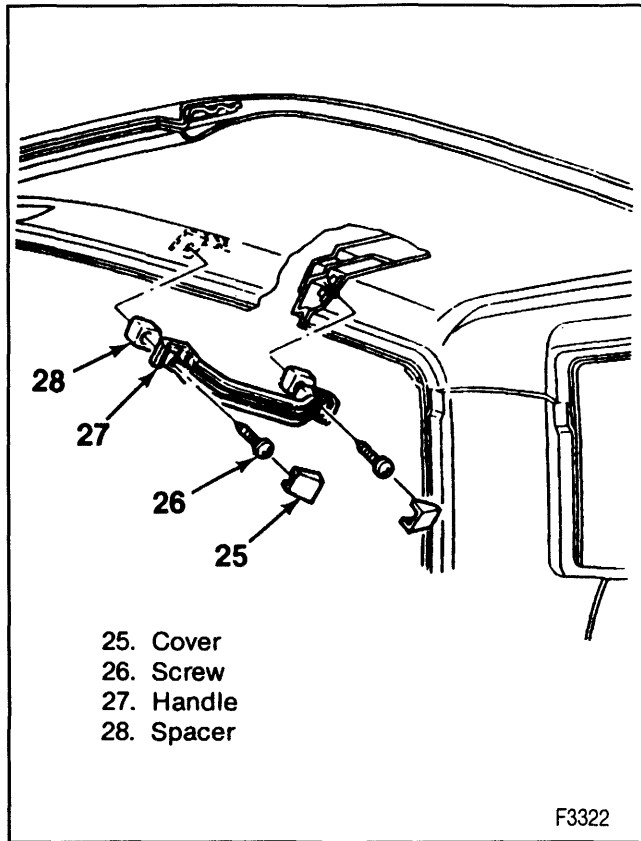


Figure 9—Assist Handle Replacement

5. Floor compartment.

→→ Install or Connect (Figure 11)

1. Floor compartment.
2. Four screws.
3. Screw plugs.
4. Storage bin.
5. Front tray.

ROOF GARNISH MOLDING REPLACEMENT

→→ Remove or Disconnect (Figure 12)

1. Upper windshield trim.
2. Roof side door trim.
3. Windshield pillar trim.

→→ Install or Connect (Figure 12)

1. Windshield pillar trim.
2. Roof side door trim.
3. Upper windshield trim.

ROOF TRIM PANEL REPLACEMENT

PICKUP

→→ Remove or Disconnect (Figure 13)

1. Sunshades.
2. Assist handle (if equipped).

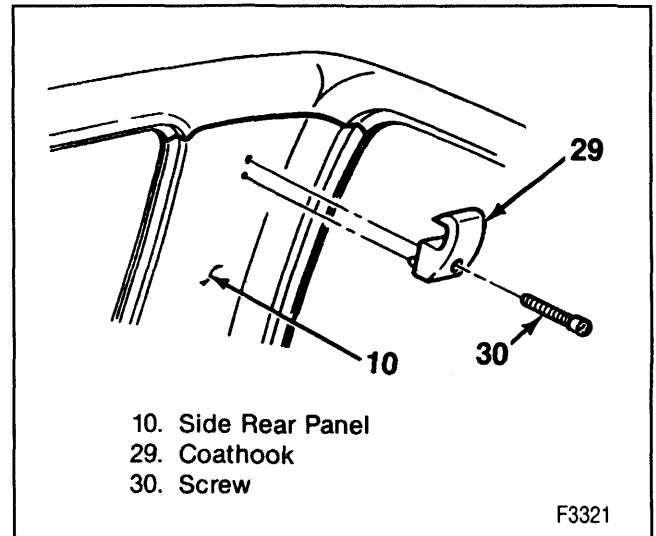


Figure 10—Coat Hook Replacement

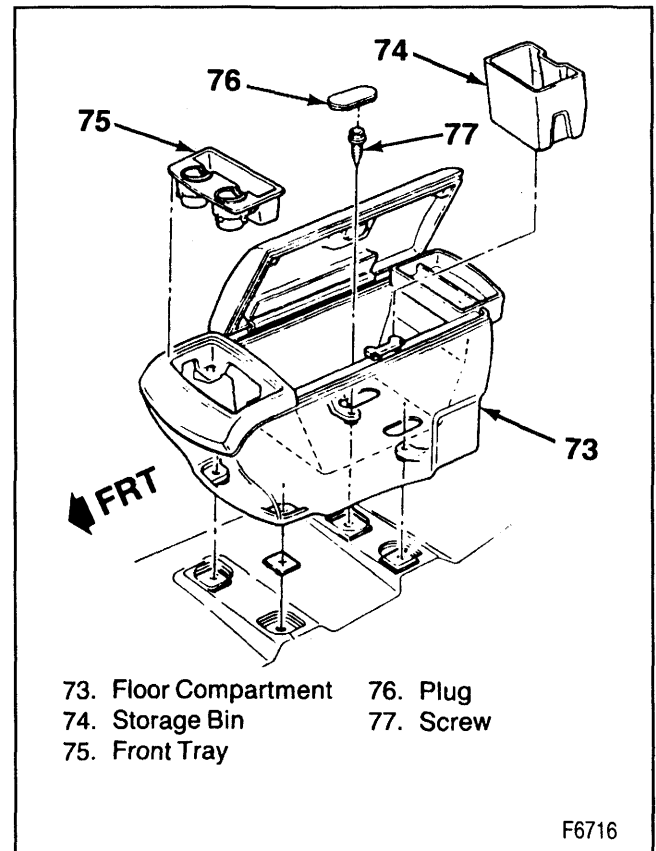


Figure 11—Front Floor Compartment

3. Rear window lower molding. Refer to "Rear Window Lower Garnish Molding Replacement."
4. Body side trim panels. Refer to "Body Side Trim Panel Replacement."
5. Rear window upper molding. Refer to "Rear Window Upper Garnish Molding Replacement."
6. Roof garnish molding. Refer to "Roof Garnish Molding Replacement."

10A4-8 INTERIOR TRIM

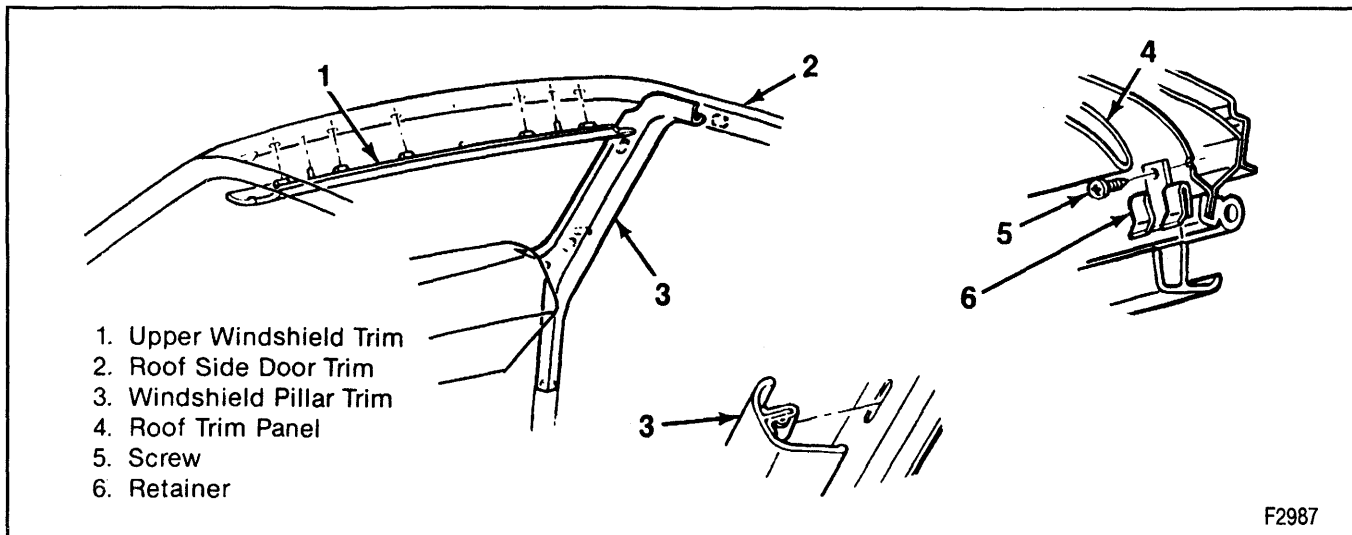


Figure 12—Roof Garnish Molding

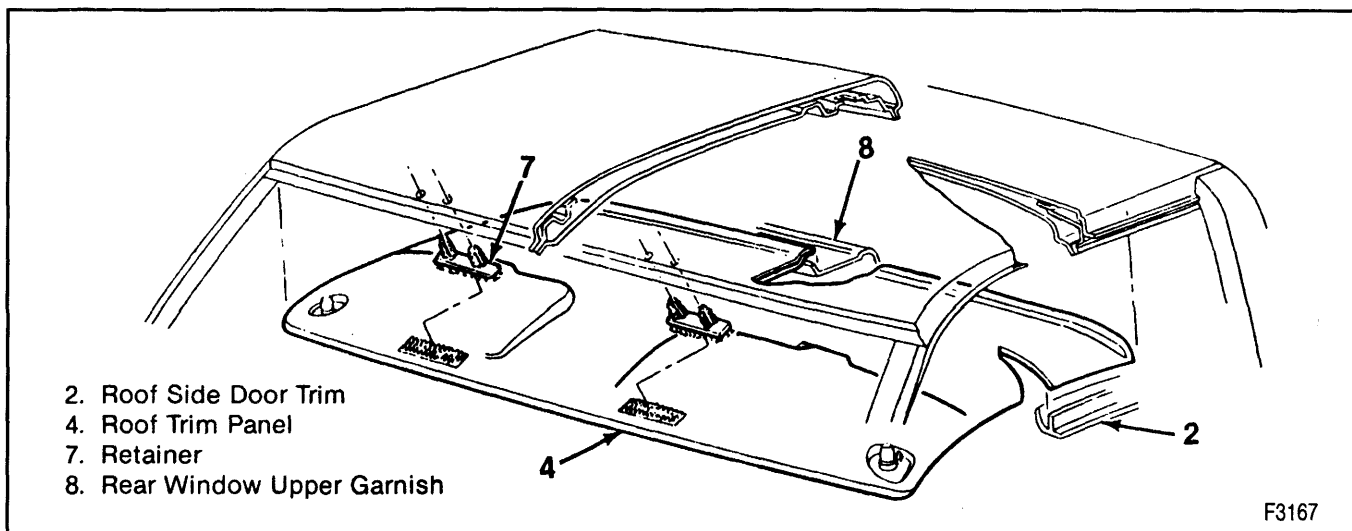


Figure 13—Roof Trim Panel (Pickup)

7. Roof trim panel.

- Grasp the panel on the left and right sides near the front of the cab.
- Disengage the front of the panel from the roof.

8. Retainers from trim panel.

Install or Connect (Figure 13)

1. Retainers to the trim panel.
2. Roof trim panel to the vehicle.
 - Insert the retainers into the windshield frame.
3. Roof garnish molding. Refer to "Roof Garnish Molding Replacement."
4. Rear window upper molding. Refer to "Rear Window Upper Garnish Molding Replacement."
5. Body side trim panels. Refer to "Body Side Trim Panel Replacement."
6. Rear window lower garnish molding. Refer to "Rear Window Lower Garnish Molding Replacement."
7. Assist handle (if equipped).
8. Sunshades.

SURBURBAN AND UTILITY

Remove or Disconnect (Figure 14)

1. Assist handles (if equipped).
2. Sunshades.
3. Windshield pillar moldings.
4. Assist handles.
5. Coat hooks.
6. Dome lights.
7. Roof garnish moldings. Refer to "Roof Garnish Molding Replacement."
8. Rear seat belt upper trim covers.
9. Side door lock pillar molding. Refer to "Pillar Molding Replacement."
10. Upper center trim panel.
11. Cargo door lock pillar molding panel. Refer to "Pillar Molding Replacement."
12. Roof console. Refer to "Roof Console Replacement."

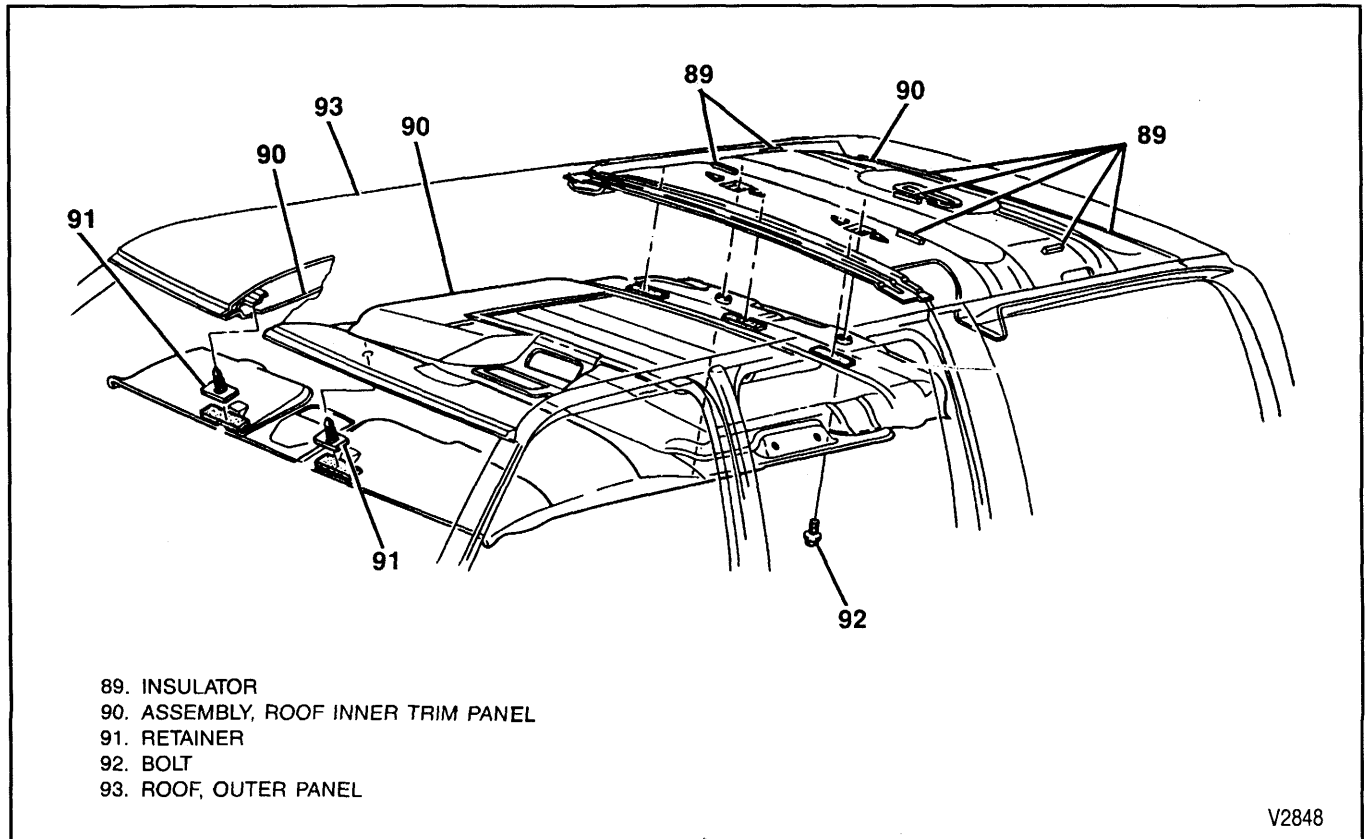


Figure 14—Roof Trim Panel (Surburban and Utility)



Install or Connect (Figure 14)

1. Roof console. Refer to "Roof Console Replacement."
2. Windshield pillar moldings.
3. Assist handles.
4. Coat hooks.
5. Dome lights.
6. Roof garnish moldings. Refer to "Roof Garnish Molding Replacement."
7. Rear seat belt upper trim covers.
8. Side door lock pillar molding. Refer to "Pillar Molding Replacement."
9. Upper center trim panel.
10. Cargo door lock pillar molding panel. Refer to "Pillar Molding Replacement."
11. Sunshades.
12. Assist handles (if equipped).

ROOF CONSOLE REPLACEMENT



Remove or Disconnect (Figure 15)

1. Console to the roof screw.
2. Electrical connectors.
3. Console from the roof.



Install or Connect (Figure 15)

1. Console to the roof.

2. Electrical connectors.
3. Console to the roof screw.



Tighten

- Console to the roof screw to 1.9 N.m (17 lbs. in.).

REAR WINDOW UPPER GARNISH MOLDING REPLACEMENT



Remove or Disconnect (Figures 16 and 17)

1. Retainer screws.
2. Molding from rear body panel.



Install or Connect (Figure 16 and 17)

1. Molding to the rear body panel.

NOTICE: Refer to "Notice" on page 10A4-1.

2. Retainer screws.



Tighten

- Upper garnish molding retainer screws to 1.9 N.m (17 lbs. in.).

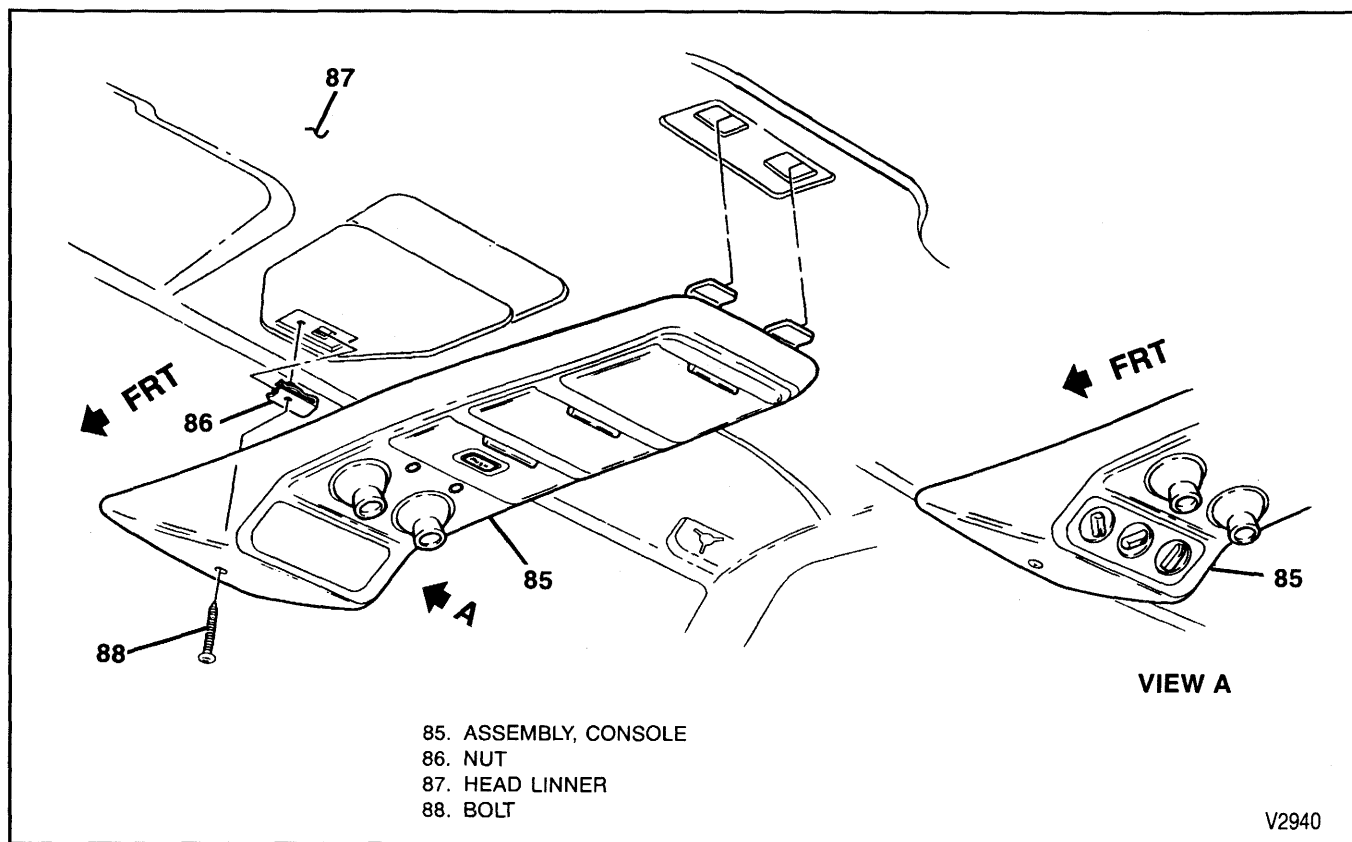


Figure 15—Roof Console

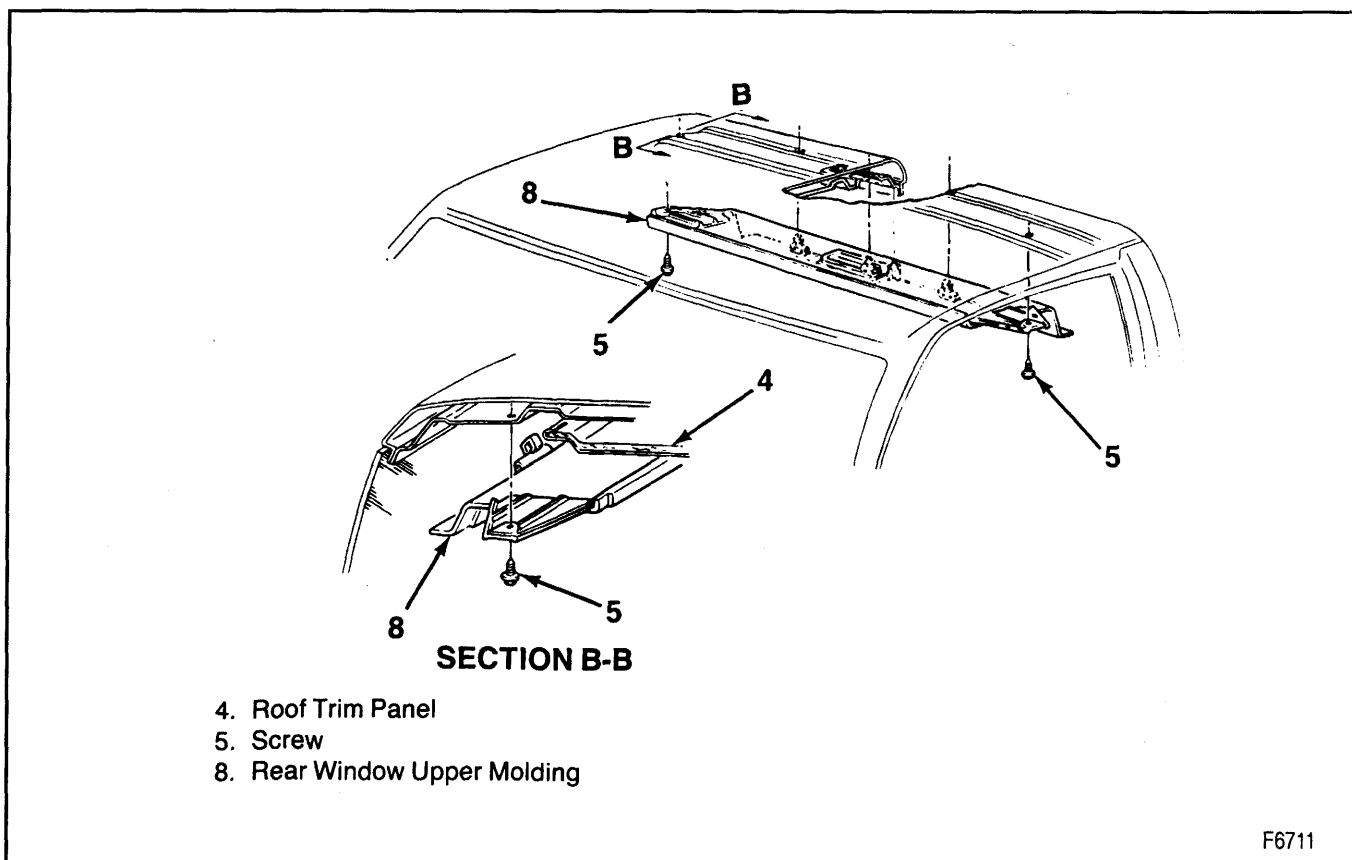


Figure 16—Rear Window Upper Garnish Molding (Regular Cab)

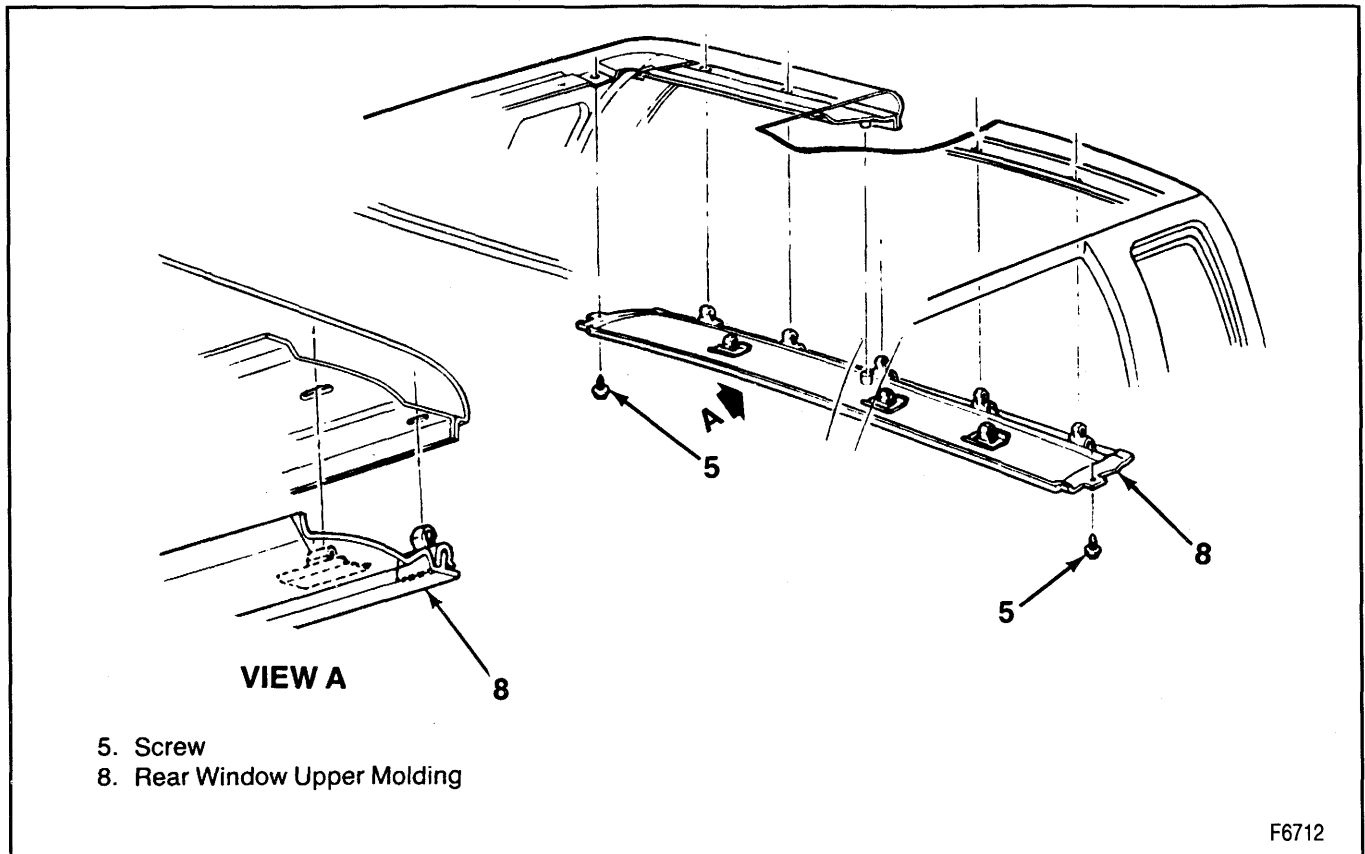


Figure 17—Rear Window Upper Garnish Molding (Extended Cab)

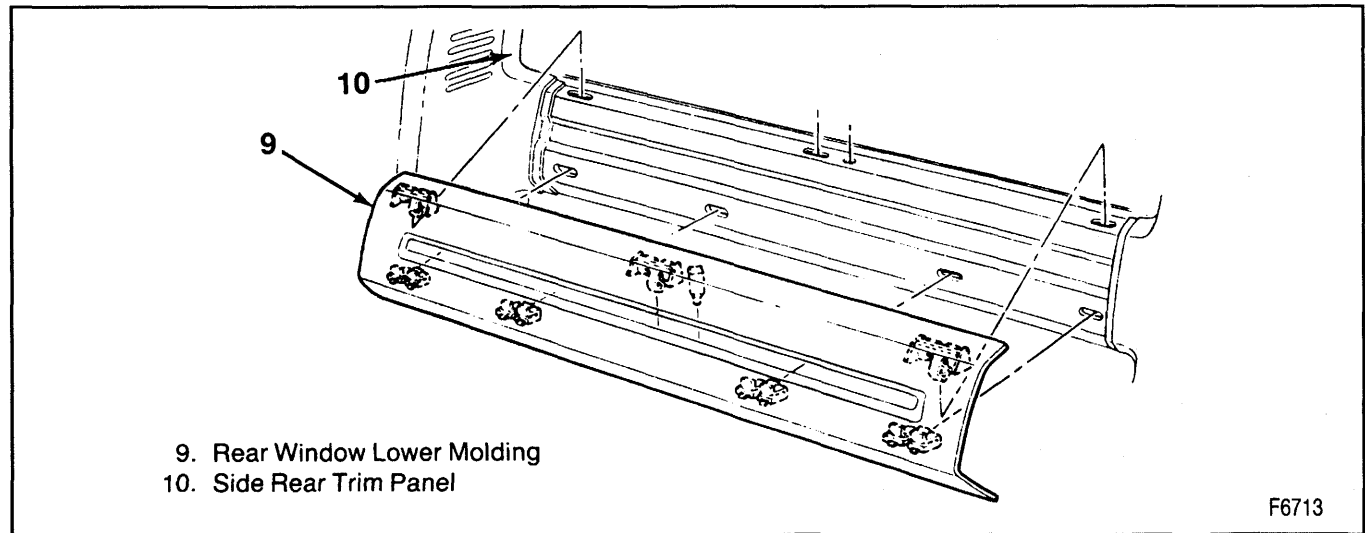


Figure 18—Rear Window Lower Garnish Molding

REAR WINDOW LOWER GARNISH MOLDING REPLACEMENT



Remove or Disconnect (Figure 18)

1. Lightly pull lower edge of molding to release the four clips.

2. Lift molding up and away from glass to release upper retainers.



Install or Connect (Figure 18)

1. Align molding clips with holes in body panel along back glass.
2. Snap molding into place applying light pressure along top of molding at glass.
3. Align lower row of molding clips and snap lower portion of molding into place.

10A4-12 INTERIOR TRIM

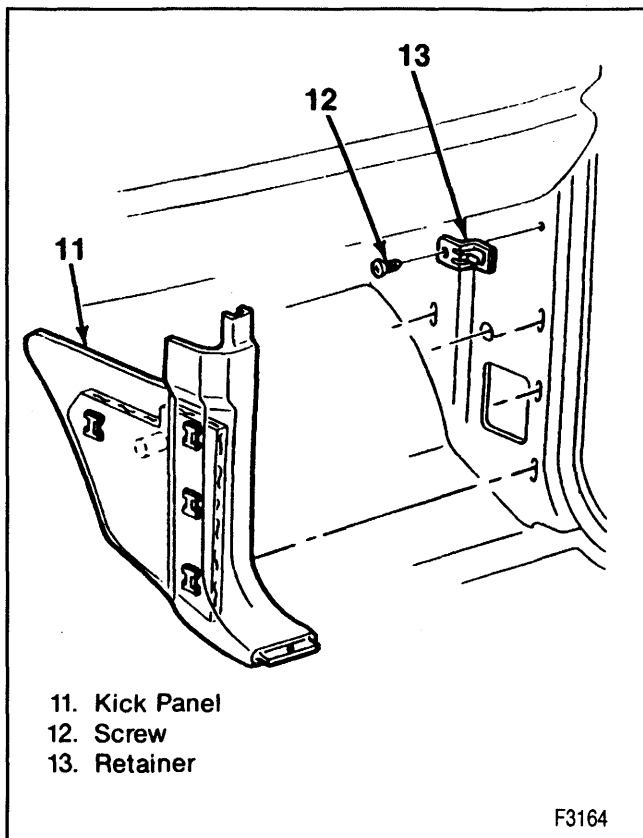


Figure 19—Cowl Side Kick Panel

COWL SIDE KICK PANEL

↔ Remove or Disconnect (Figure 19)

1. Retainer screw.
2. Kick panel from the retainers.

→← Install or Connect (Figure 19)

1. Kick panel to the retainers.
2. Retainer screw.

BODY SIDE TRIM PANEL (REGULAR CAB, EXTENDED CAB, AND CREW CAB)

↔ Remove or Disconnect (Figures 20 and 21)

1. Coat hook.
2. Seat belt guide.
3. Seat belt retractor. Refer to SECTION 10A2.
4. Jack cover, jack, and jack tray (right side).
5. Rear window lower garnish molding. Refer to "Rear Window Lower Garnish Molding Replacement."
6. Body side trim panel screws (regular and crew cab only).
7. Rear screw from the sill plate (regular and crew cab only).
8. Body side trim panel.

→← Install or Connect (Figures 20 and 21)

1. Body side trim panel.

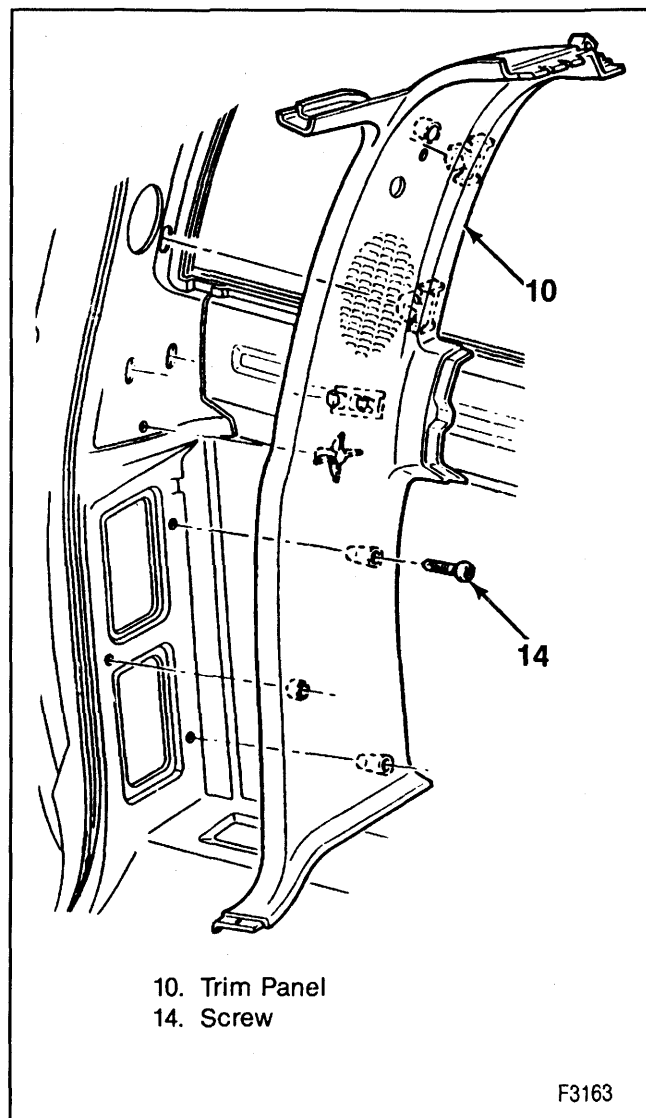


Figure 20—Body Side Trim Panel (Regular and Crew Cab)

NOTICE: Refer to "Notice" on page 10A4-1.

2. Panel screws (regular and crew cab only).

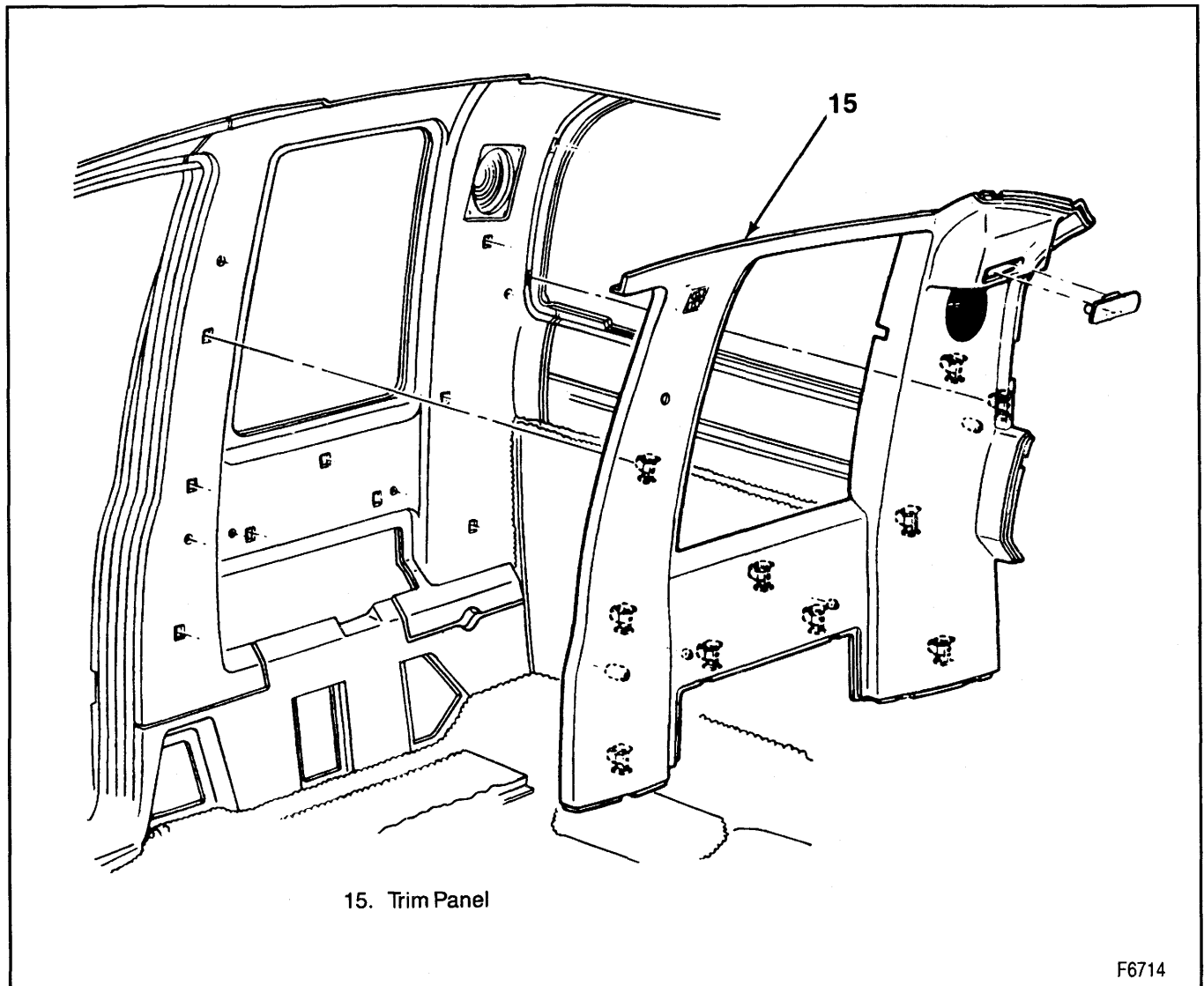
⌚ Tighten

- Trim panel screws to 1.9 N.m (17 lbs. in.).
3. Rear screw into the sill plate.
 4. Rear window lower garnish molding.
 5. Jack tray, jack, and cover (right side)
 6. Seat belt retractor.
 7. Seat belt guide.
 8. Coat hook.

BODY SIDE REAR LOWER TRIM PANEL (REGULAR AND EXTENDED CAB)

↔ Remove or Disconnect (Figures 22 and 23)

1. Armrest (if present).
2. Pocket from the lower panel (if present).
3. Lower panel screws.



15. Trim Panel

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Figure 21—Body Side Trim Panel (Extended Cab)

4. Panel from the body frame.

↔ Install or Connect (Figures 22, 23 and 24)

1. Panel to the body frame.
2. Lower panel screws.
3. Pocket to the lower panel (if present).
4. Armrest (if present).

PILLAR MOLDINGS (SUBURBAN, UTILITY AND CREW CAB)

↔ Remove or Disconnect (figure 25, 26 and 28)

1. Door sill plate screws.
2. Door sill plates.
3. Seat belt to pillar anchors (side door lock pillars only). Refer to SECTION 10A2.
4. Pillar molding screws
5. Pillar moldings.

↔ Install or Connect (Figure 25, 26 and 28)

1. Pillar moldings.

NOTICE: Refer to "Notice" on page 10A4-1.

2. Pillar moldings screws to pillar.

⦿ Tighten

- Body side pillar molding screws to 1.9 N.m (17 lbs. in.).
3. Seat belt anchors to pillars. Refer to SECTION 10A2.
 4. Door sill plates.
 5. Door sill plate screws.

BODY SIDE TRIM PANELS (SUBURBAN AND UTILITY)

RIGHT SIDE

↔ Remove or Disconnect (Figures 27 and 28)

1. Rear seat. Refer to SECTION 10A2.
2. Arm rest to side panel screws. (Suburban only)
3. Arm rest from the body side panel.
4. Rear blower motor trim cover.

10A4-14 INTERIOR TRIM

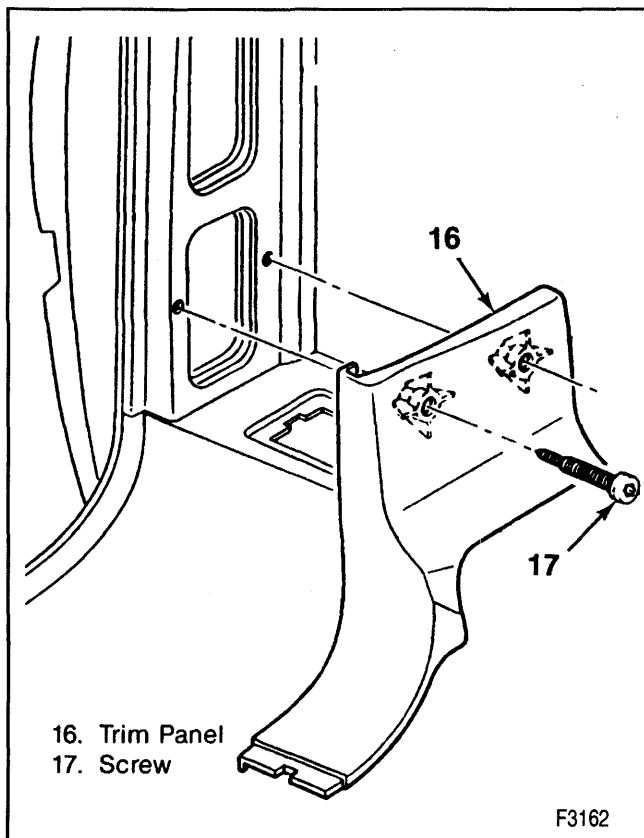


Figure 22—Side Rear Lower (Regular Cab)

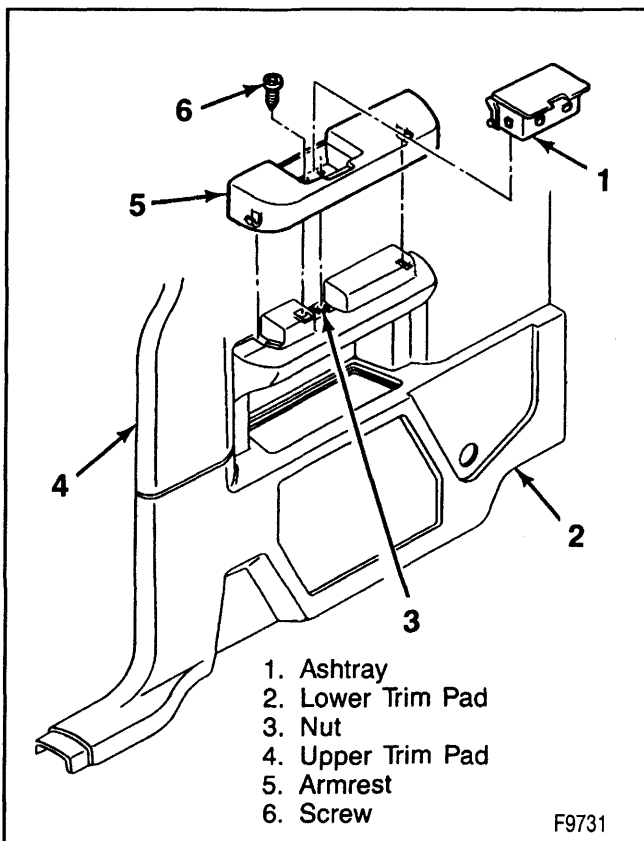


Figure 23—Side Rear Lower Panel (Extended Cab with Armrest)

5. Cargo door pillar molding. Refer to "Pillar Molding Replacement."
6. Rear door lock pillar molding (Surburban only). Front door lock pillar molding (Utility). Refer to "Pillar Molding Replacement."
7. Body side trim panel screws.
8. Body side trim panel from the vehicle.
 - Lift panel to release from body side.



Install or Connect (Figure 27 and 28)

NOTICE: For steps 2 and 8, refer to "Notice" on page 10A4-1.

1. Body side trim panel to the vehicle.
2. Body side trim panel screws.



Tighten

- Body side trim panel screws to 1.9 N·m (17 lbs. in.).
3. Rear door lock pillar molding to pillar (Surburban only).
 4. Front door lock pillar molding to pillar (Utility only).
 - Refer to "Pillar molding Replacement."
 5. Cargo door pillar molding to pillar.
 - Refer to "Pillar Trim Panel Replacement."
 6. Rear blower motor trim cover.
 7. Arm rest to body side trim panel.
 8. Arm rest to the body side trim panel screws.



Tighten

- Arm rest to the body side trim panel screws to 1.9 N·m (17 lbs. in.).
9. Rear seat. Refer to SECTION 10A2.

LEFT SIDE



Remove or Disconnect (Figure 28 and 29)

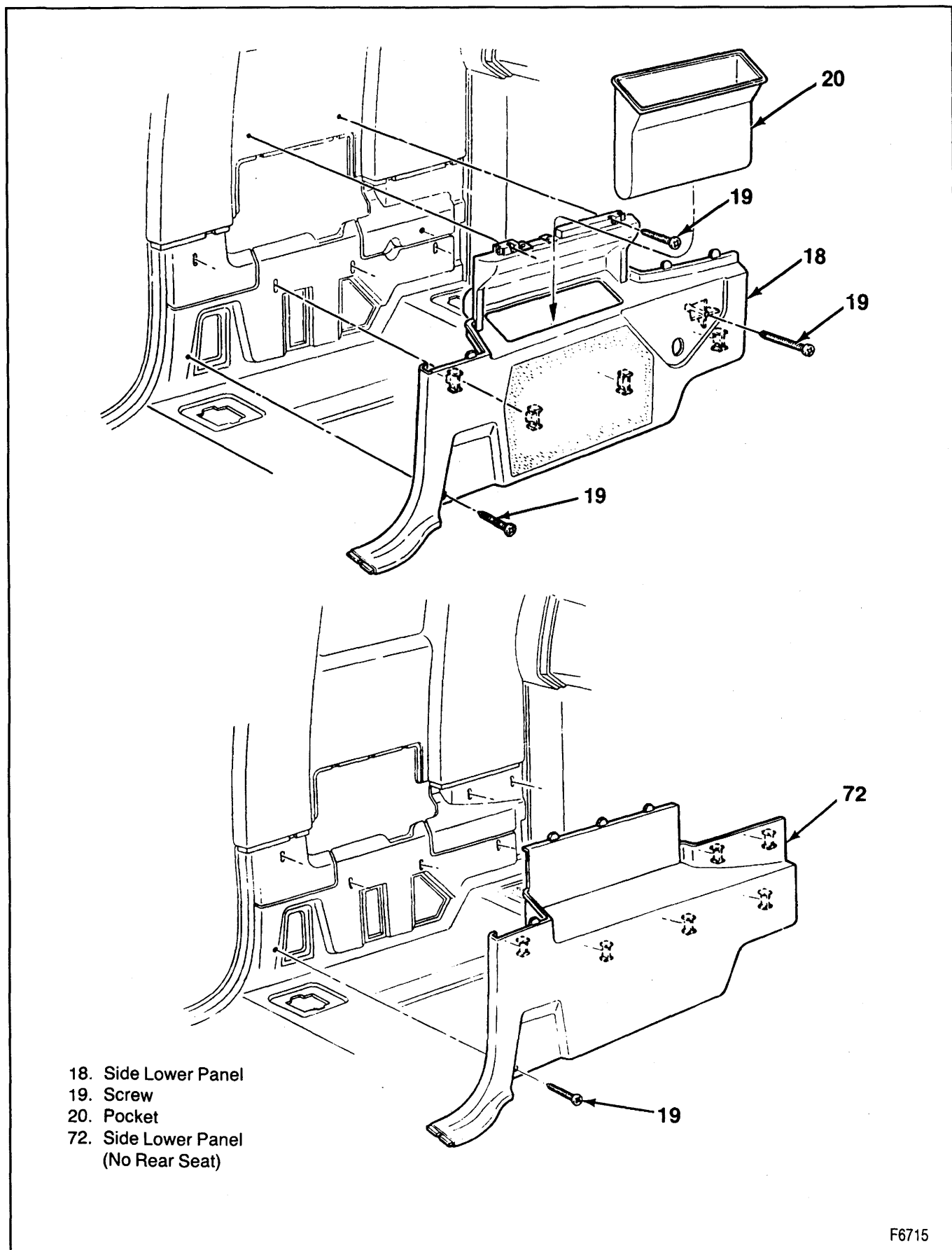
1. Rear seat. Refer to SECTION 10A2.
2. Spare tire cover.
3. Spare tire. Jack (utility).
4. Spare tire rest trim covers.
5. Spare tire rest bolts.
6. Spare tire rest from the vehicle.
7. Spare tire holder from the floor.
8. Spare tire I-bolt from the body side.
9. Arm rest.
10. Cargo door pillar moldings. Refer to "Pillar Trim Panel Replacement".
11. Intermediate seat belt to rear door pillar bolt. Refer to SECTION 10A2.
12. Intermediate seat belt anchor to the floor bolt. Refer to SECTION 10A2.
13. Rear door lock pillar molding. Refer to "Pillar trim Panel replacement."
14. Body side trim panel screws.
15. Body side trim panel from the vehicle.



Install or Connect (Figure 28)

1. Body side trim panel to vehicle.

NOTICE: Refer to "Notice" on page 10A4-1.



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Figure 24—Side Rear Lower Panel (Extended Cab With And Without Pocket)

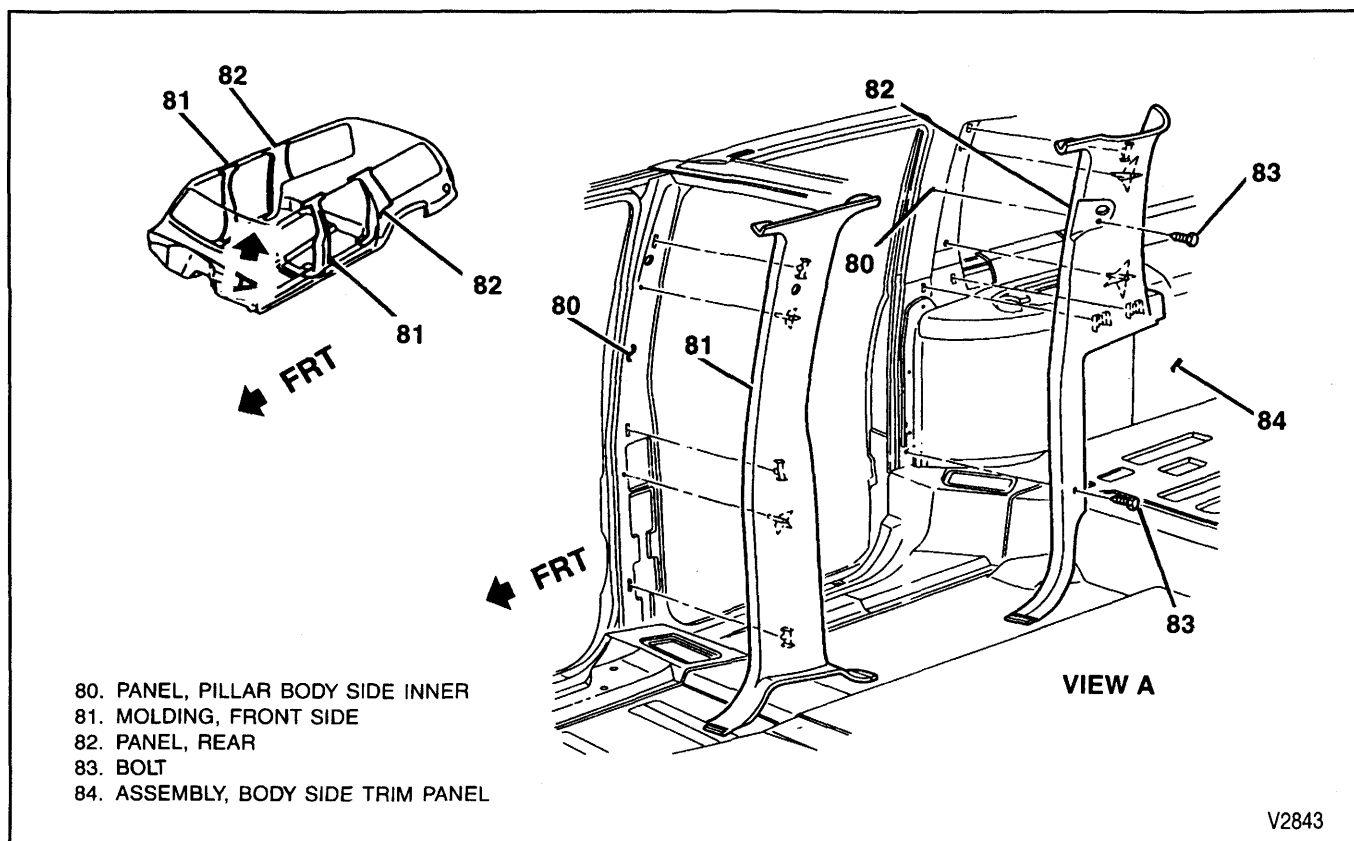


Figure 25—Pillar Moldings

2. Body side trim panel screws.



Tighten

- Tighten trim panel to vehicle screws to 1.9 N.m (17 lbs. inch.).

3. Rear door lock pillar trim panel (Surburban only). Front door lock pillar (Utility only). Refer to "Pillar trim panel replacement".
4. Intermediate seat belt anchor to floor bolt.
5. Intermediate seat belt to rear door pillar bolt.
6. Cargo door pillar trim panels to pillar. Refer to "Pillar Trim Panel Replacement".
7. Arm rest.
8. Spare tire I-bolt to body side.
9. Spare tire holder to floor.
10. Spare tire rest to vehicle.
11. Spare tire rest bolts.
12. Spare tire rest covers. Jack (utility).
13. Spare tire.
14. Spare tire cover.

REAR PANEL CARPET REPLACEMENT



Remove or Disconnect (Figure 30)

1. Rear window lower garnish molding.
2. Side rear trim panel.
3. Side rear lower panel.
4. Carpet retainers.

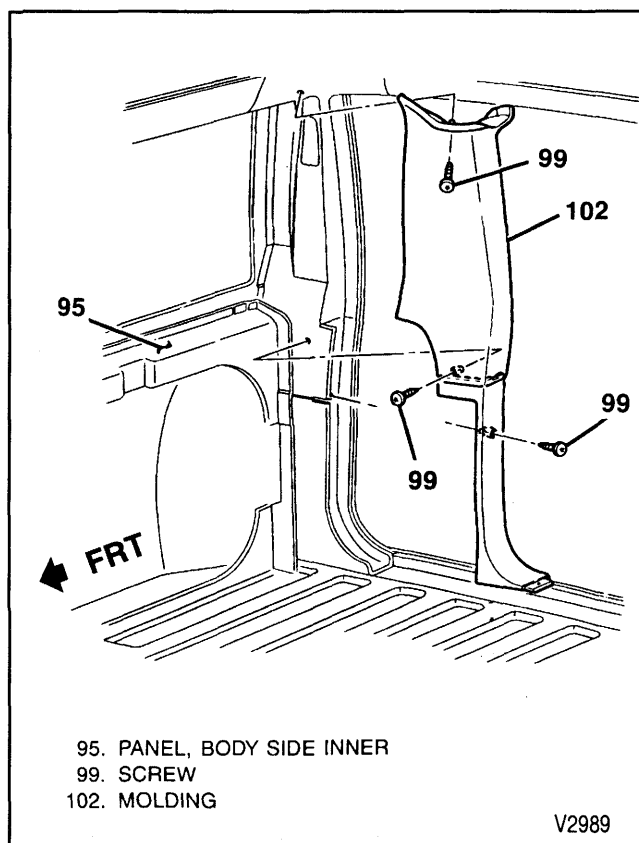


Figure 26—Cargo Door Pillar Molding

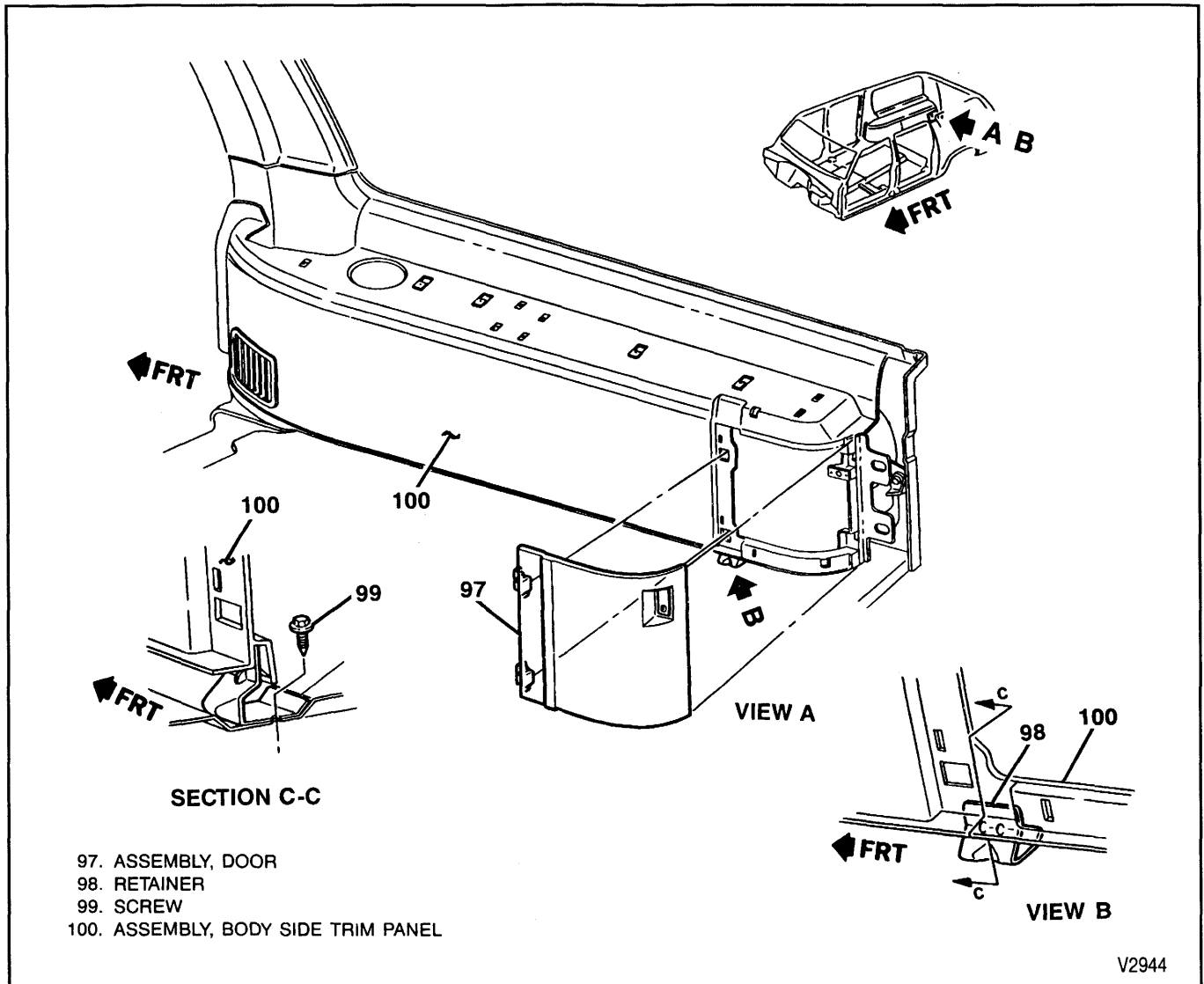


Figure 27—Right Body Side Trim Panel (Surburban)

- 5. Carpet panel (Extended, Regular and Crew cab)
- 6. Carpet.



Install or Connect (Figure 30)

- 1. Carpet.
- 2. Carpet panel.

- 3. Carpet retainers.
- 4. Side rear lower panel.
- 5. Side rear lower panel.
- 6. Rear window lower garnish molding.

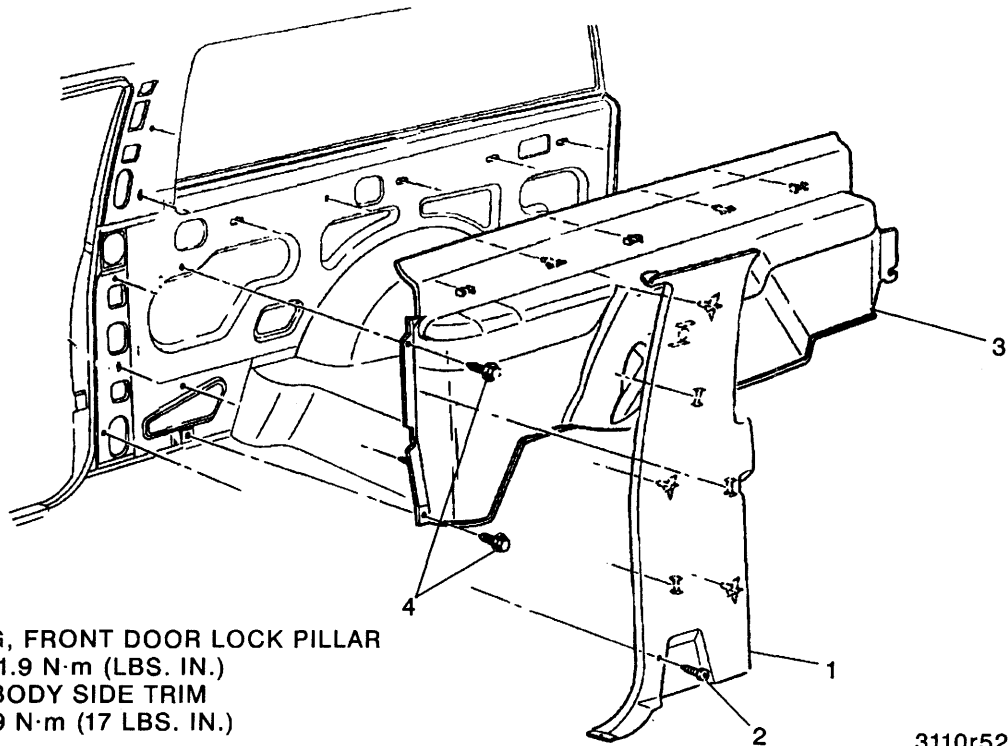


Figure 28—Body Side Trim Panel (Utility)

1. PANEL, LEFT BODY SIDE TRIM
2. BOLT, 1.9 N·m (17 LBS. IN.)
3. ARMREST

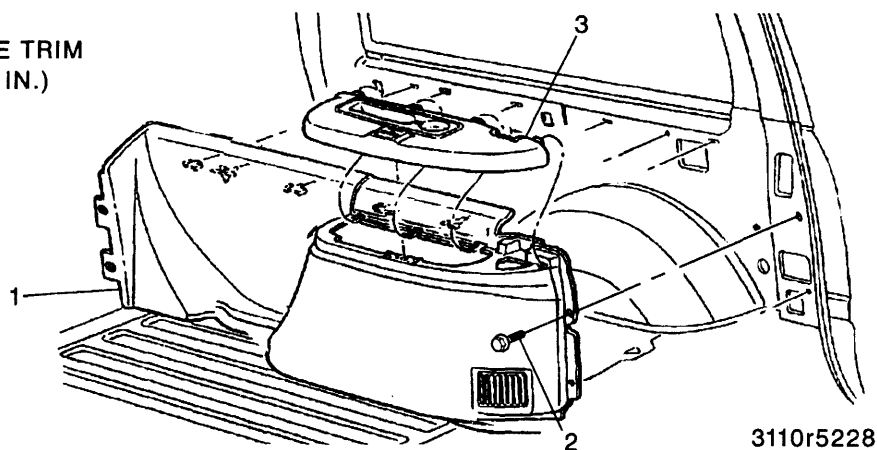


Figure 29—Left Body Side Panel (Suburban)

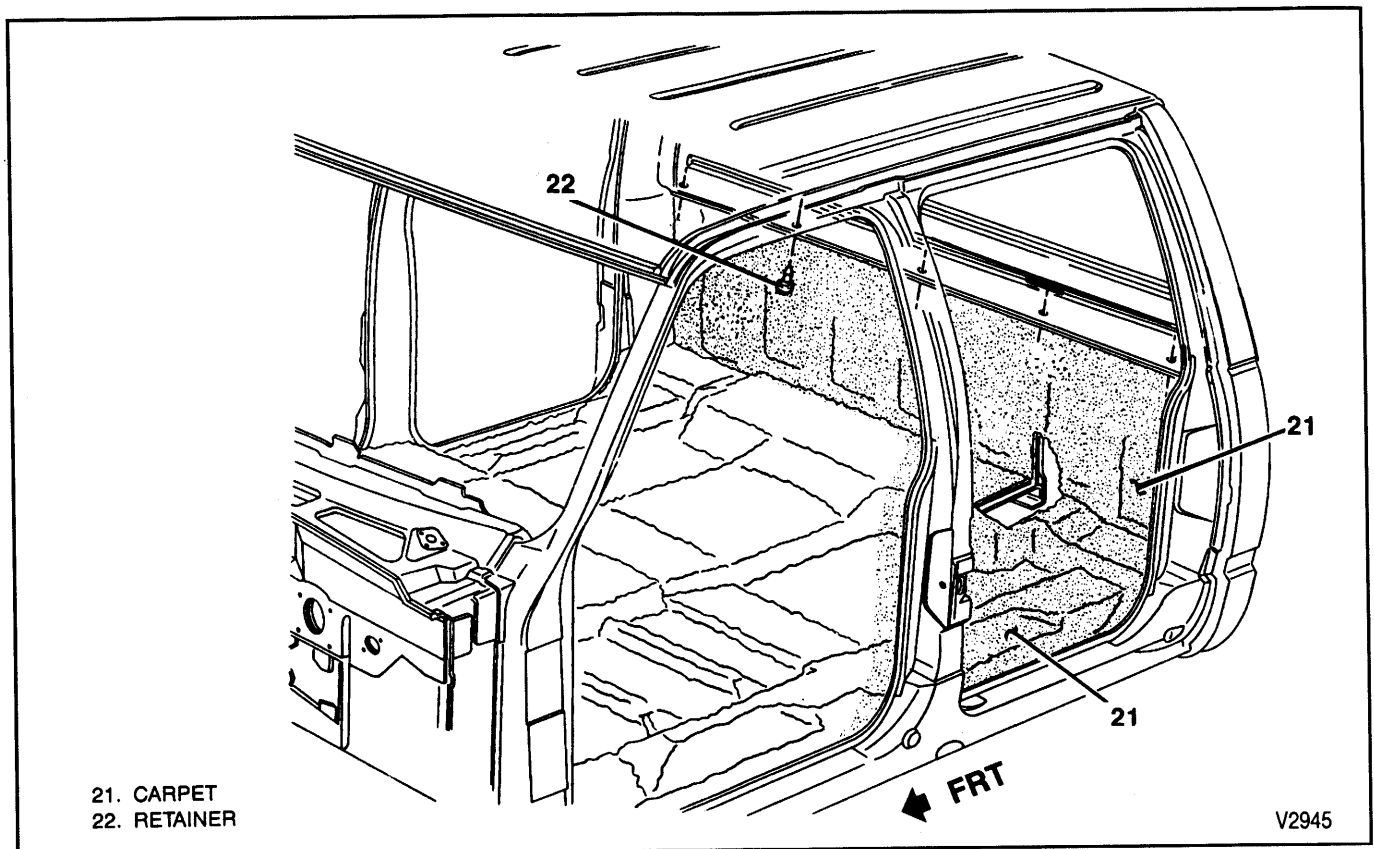


Figure 30—Rear Carpet

10A4-20 INTERIOR TRIM

INTERIOR COLORS

NOTE: GM code numbers * indicates 12% gloss and 5% gloss available. DuPont paints must have a vinyl resin added to obtain the required gloss. All other companies use a two number system. The top number indicates a 12% gloss and the bottom number indicates a 5% gloss which is used only on the instrument panel.

GM Code	Fisher Code	Color	DuPont No.	PPG Ditzler No.	Martin Senour	Sherwin Williams	BASF
						Acme/Rogers	
13AN*	9653	Light Gray	C9109	**	44438	44438	21029
				**	44437	44437	21026
13BN*	9654	Medium Gray	C9110	**	44439	44439	21027
				**	45940	45940	22281
13CN*	9655	Dark Gray	C9111	**	45941	45941	22282
				**	44440	44440	21028
19DN	848	Black	C8535	**	16915	92387	12812
				**	16918	33024	4401
24CN*	9059	Dark Blue	C8792	**	36478	36478	17124
				**	39838	39838	19021
24DN*	8576	Very Dark Blue	C8539	**	17075	34606	16045
				**	17067	34598	15080
26I	152A	Dark Navy Blue	C9403	**	48704	48704	24132
				**	48703	48703	24133
47CN*	9104	Dark Red	C9007	**	42602	42602	20061
				**	42601	42601	20062
47DN*	9253	Very Dark Red	C9008	**	42604	42604	20063
				**	42603	42603	20064
64AN*	9776	Light Beige	C9202	**	45942	45942	22275
				**	45943	45943	22276
64BN*	9777	Medium Beige	C9203	**	45944	45944	22277
				**	45945	45945	22278
64DN*	9778	Dark Beige	C9204	**	45946	45946	22279
				**	45947	45947	22280

**Not available at time of printing.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener	N·m	Ft. Lbs.
Carrier Bracket Bolts.....	20	15
Seat Mounting Bolt.....	17	12
		T2155

SECTION 10A5

END GATE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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ON VEHICLE SERVICE FOR PICKUP MODELS

END GATE REPLACEMENT

 Remove or Disconnect (Figures 1 and 2)

- Lower the end gate to a horizontal position.
 - Pull up on the middle of the cable assembly.
 - With the aid of a helper, raise the end gate 45-degrees.
1. Cable on each side from the side panel striker bolts (figure 2).
 2. End gate from the right side hinge assembly and then the left hinge assembly with the aid of a helper.

 Install or Connect (Figures 1 and 2)

- Use a helper to lift the end gate.

1. End gate to side panel hinge assemblies holding the gate at a 45-degree angle (figure 2).
2. Cable on each side onto the side panel striker bolts (figure 2).

END GATE LATCH OPERATING HANDLE REPLACEMENT

 Remove or Disconnect (Figure 3)

- Lower the end gate.
1. Three bolts and washers from the back of the end gate behind the handle.
 - Raise the end gate.

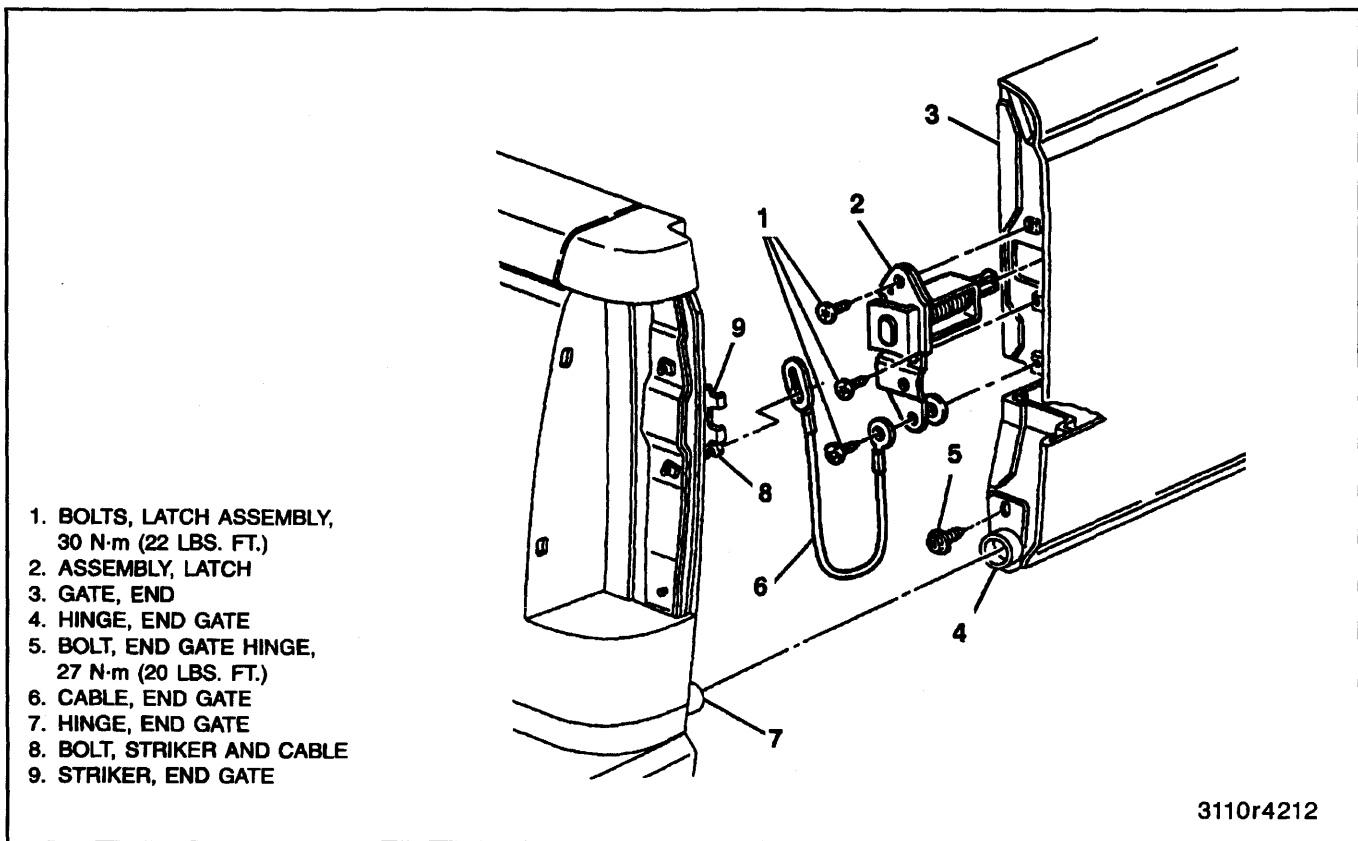


Figure 1—End Cable and Latch Components

2. Bezel from around the handle by prying gently.

Inspect

- Bezel for damage to the retention prongs. If any of them are broken or bent, replace the bezel.
3. Latch operating rods from the retainers on the handle by pushing the rods back.
 4. Handle assembly from the end gate.

Install or Connect (Figure 3)

1. Handle assembly into the end gate.
2. Latch operating rods into the retainers on the handle.
3. Bezel to the handle and end gate.
 - Lower the end gate.

NOTICE: Refer to "Notice" on page 10A5-1.

4. Three bolts and washers into the handle from the back of the end gate.

Tighten

- End gate to handle bolts to 25 N·m (18 lbs. ft.).

END GATE LATCH AND ROD REPLACEMENT

Remove or Disconnect (Figure 1 and 3)

1. Operating handle. Refer to "End Gate Latch Operating Handle Replacement."

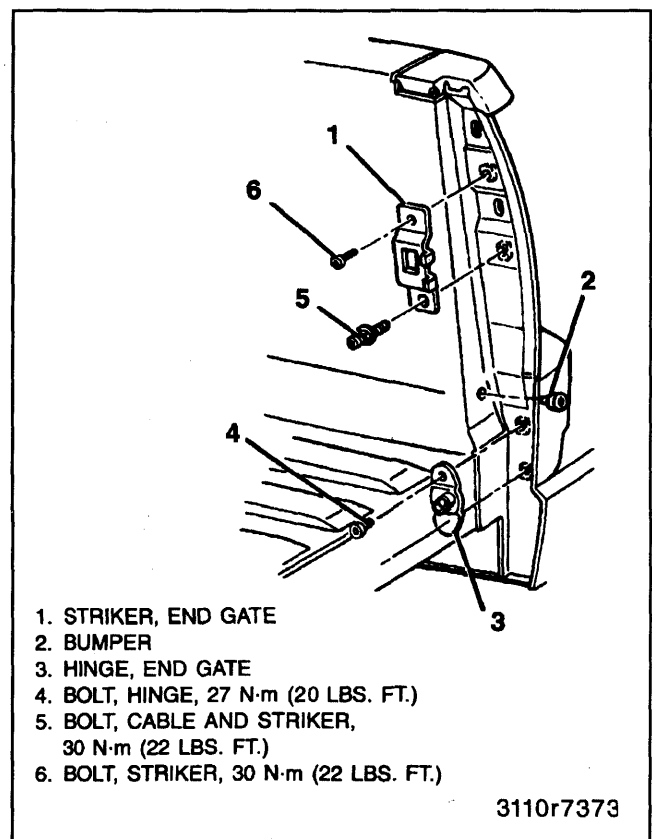


Figure 2—Side Panel Striker and Hinge Components

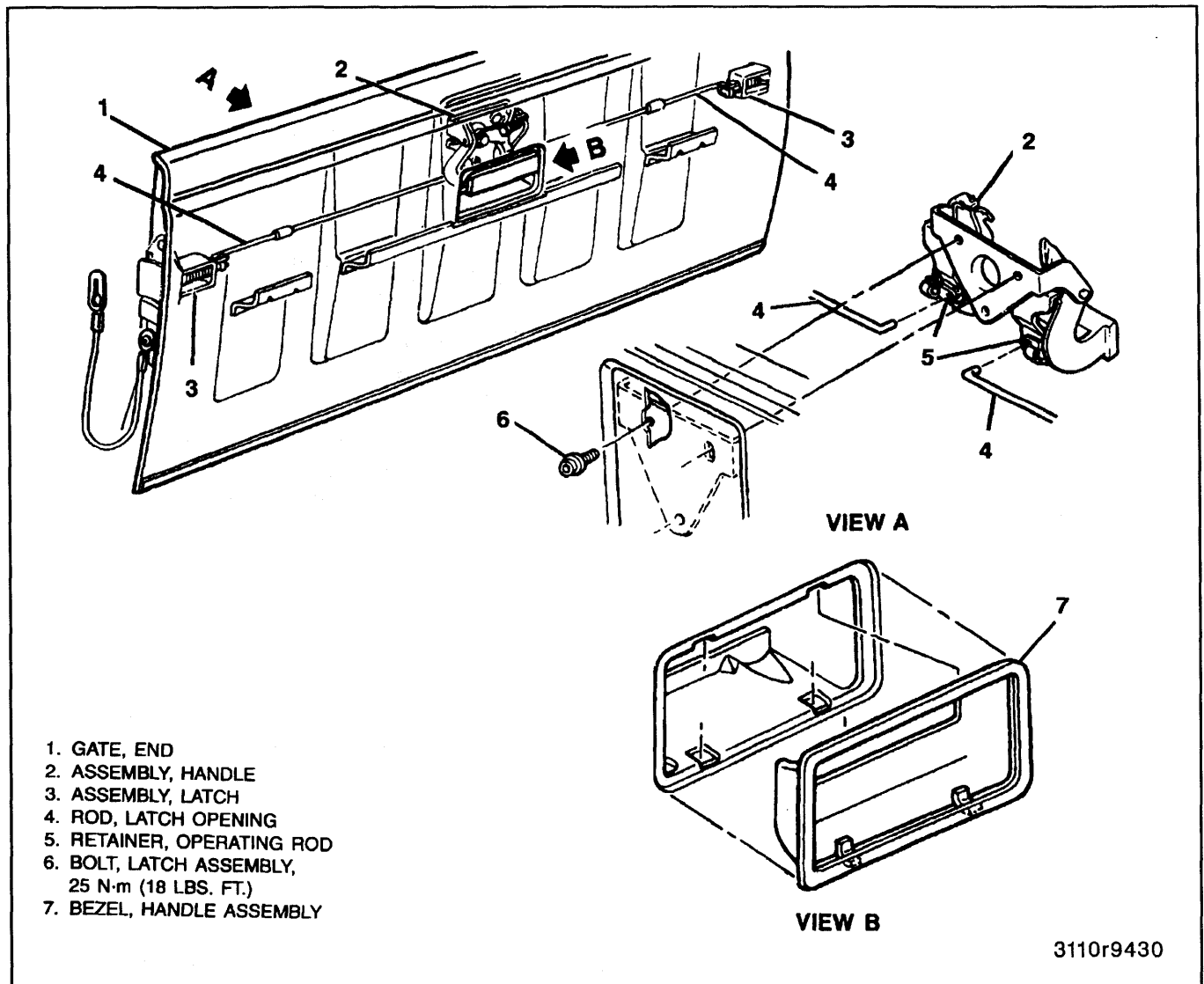


Figure 3—Latch Operating Handle

- Lower and support the end gate and lift the cables off the striker bolts.
- 2. Three bolts holding the latch assembly to the end gate.
- 3. Latch assembly and rod.

→→ Install or Connect (Figures 1 and 3)

1. Latch assembly and rod to the end gate.

NOTICE: Refer to "Notice" on page 10A5-1.

2. Three bolts holding the latch assembly to the end gate (figure 1).



Tighten

- Latch to end gate bolts to 30 N·m (22 lbs. ft.).
- Raise the end gate and attach the cables to the striker bolts.
- 3. Operating handle. Refer to "End Gate Latch Operating Handle Replacement."

STRIKER AND STRIKER BOLT REPLACEMENT



Remove or Disconnect (Figure 2)

- Lower the end gate to a support and lift the cables off the striker bolts.
- 1. Striker and cable bolt.
- 2. Striker bolt.
- 3. Striker.



Install or Connect (Figure 2)

NOTICE: For steps 2 and 3, refer to "Notice" on page 10A5-1.

1. Striker to the side panel.
2. Striker bolt.



Tighten

- Striker bolt to 30 N·m (22 lbs. ft.).
- 3. Striker and cable bolt.

10A5-4 END GATE



Tighten

- Striker and cable bolt to 30 N.m (22 lbs. ft.).
- Raise the end gate and attach the cables to the striker bolts.

SIDE PANEL LOWER HINGE REPLACEMENT



Remove or Disconnect (Figure 2)

1. End gate. Refer to "End Gate Replacement."
2. Bolts from the panel hinge.
3. Hinge from the side panel.



Install or Connect (Figure 2)

1. Hinge to the side panel.

NOTICE: Refer to "Notice" on page 10A5-1.

2. Lower panel hinge bolts.



Tighten

- Bolts to 27 N.m (20 lbs. ft.).
3. End gate to the side panels.

END GATE HINGE REPLACEMENT



Remove or Disconnect (Figure 1)

1. End gate. Refer to "End Gate Replacement."
 - Mark the position of the hinge on the end gate.
2. Hinge bolt.
3. Hinge from the end gate.
 - Drill a pilot hole in the weld plug.
 - Drill out the weld plug from the end gate side of the hinge with a 3/8-inch drill bit.



Install or Connect (Figure 1)

1. Hinge to the end gate. Use the marks made previously to position it.

NOTICE: Refer to "Notice" on page 10A5-1.

2. Hinge bolt.



Tighten

- Hinge to end gate bolt to 27 N.m (20 lbs. ft.).
 - Plug weld the hole that was drilled in the end gate.
 - MIG weld the hinge to the end gate around the edge of the hinge.
 - Paint and lubricate the hinge.
3. End gate to the pickup box.

ON-VEHICLE SERVICE FOR UTILITY VEHICLES

END GATE REPLACEMENT



Remove or Disconnect (Figures 4 and 5)

- Open the end gate to a horizontal position.
1. Torque rod. Refer to "Torque Rod Replacement."
 2. Electrical connector for rear window release.
 - Support the end gate in a horizontal position with a suitable support.
 3. Support cable bolts and washers.
 4. Hinge pin clips.
 - Spread the clip enough to move the clip above the recess in the pin.
 - As the pin is removed, the clip will ride on the pin, and fall free of the pin.
 5. Hinge pins from the right and left hinges.
 6. End gate from the vehicle.



Install or Connect (Figures 4 and 5)

1. End gate to the vehicle.
 - Support the end gate in a horizontal position with a suitable support.
2. Hinge pins into the left and right hinges.
3. Hinge pin clips to the hinge pins.

NOTICE: Refer to "Notice" on page 10A5-1.

4. Support cable bolts and washers.



Tighten

- Support cable to body bolts to 29 N.m (21 lbs. ft.).
5. Electrical connector for rear window release.
 6. Torque rod. Refer to "Torque Rod Replacement."

TORQUE ROD REPLACEMENT



Remove or Disconnect (Figure 5)

1. Bolt at left end with end gate open.
2. Rear bumper. Refer to SECTION 2A.
3. Rear bumper filler panel. Refer to SECTION 2A.
4. Bolts retaining the torque rod to the end gate.
 - With the gate in the closed position, the bolts are accessible from under the vehicle.
5. Torque rod and retainers.



Install or Connect (Figure 5)

NOTICE: For steps 2 and 3, refer to "Notice" on page 10A5-1.

1. Torque rod and retainers to vehicle.
 - With the gate in the closed position, place the torque rod and retainers onto the vehicle.

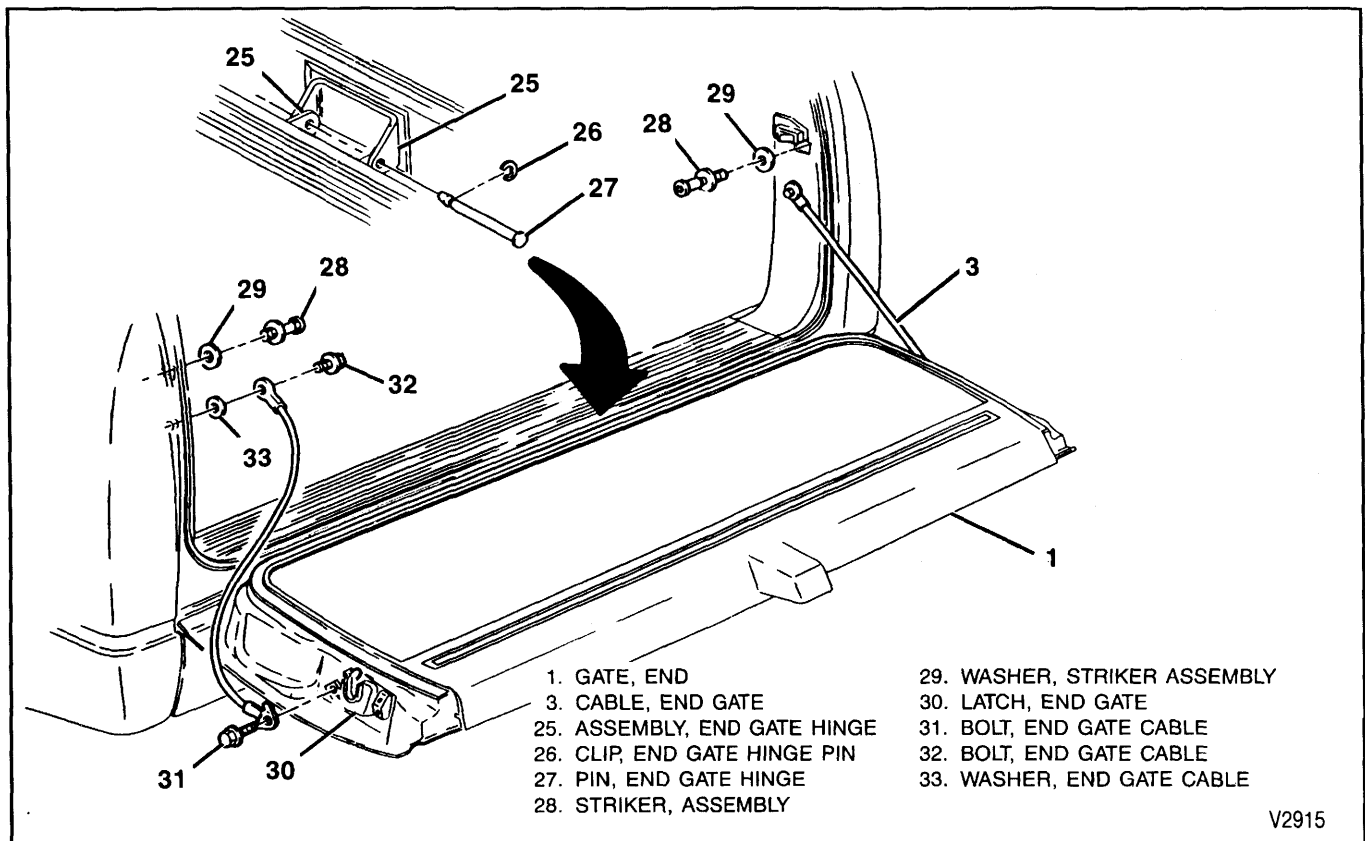


Figure 4—End Gate Replacement

2. Bolts to the torque rod retainers.



Tighten

- Torque rod retainer bolts to 15 N.m (11 lbs. ft.).

3. Bolt at left end with end gate open.



Tighten

- Torque rod retainer bolt to 15 N.m (11 lbs. ft.).

4. Rear bumper filler panel. Refer to SECTION 2A.

5. Rear bumper. Refer to SECTION 2A.

TRIM PANEL REPLACEMENT



Remove or Disconnect (Figure 6)

- Lower the end gate.

1. Trim panel to end gate screws.

2. Trim panel from the end gate.



Install or Connect (Figure 6)

1. Trim panel to the end gate.

NOTICE: Refer to "Notice" on page 10A5-1.

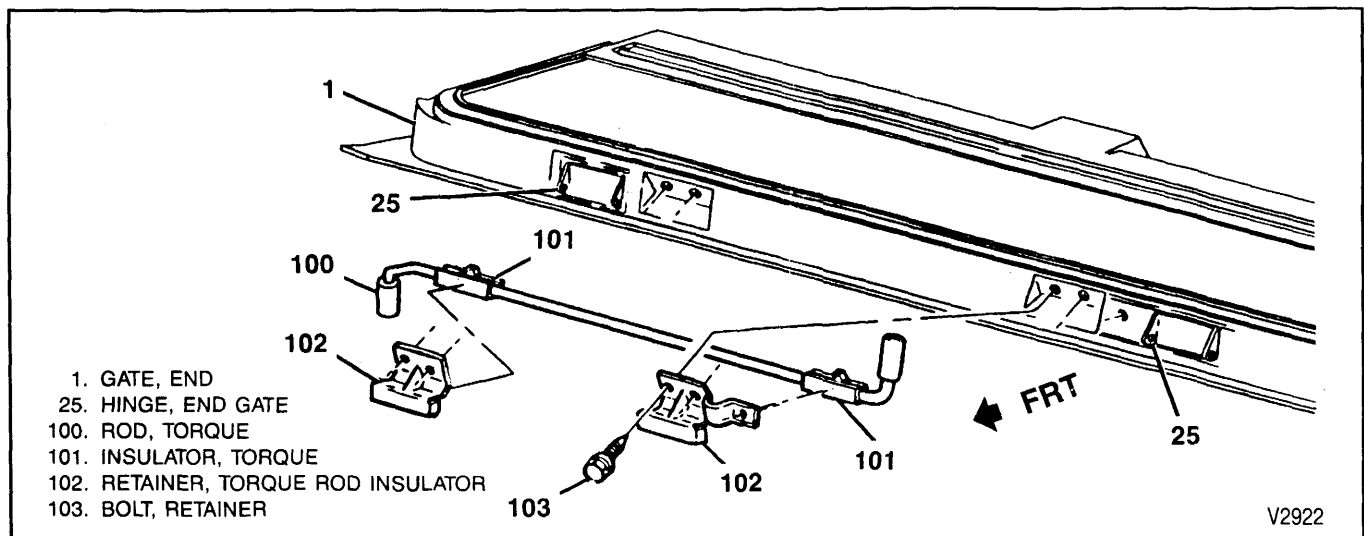


Figure 5—Torque Rod Replacement

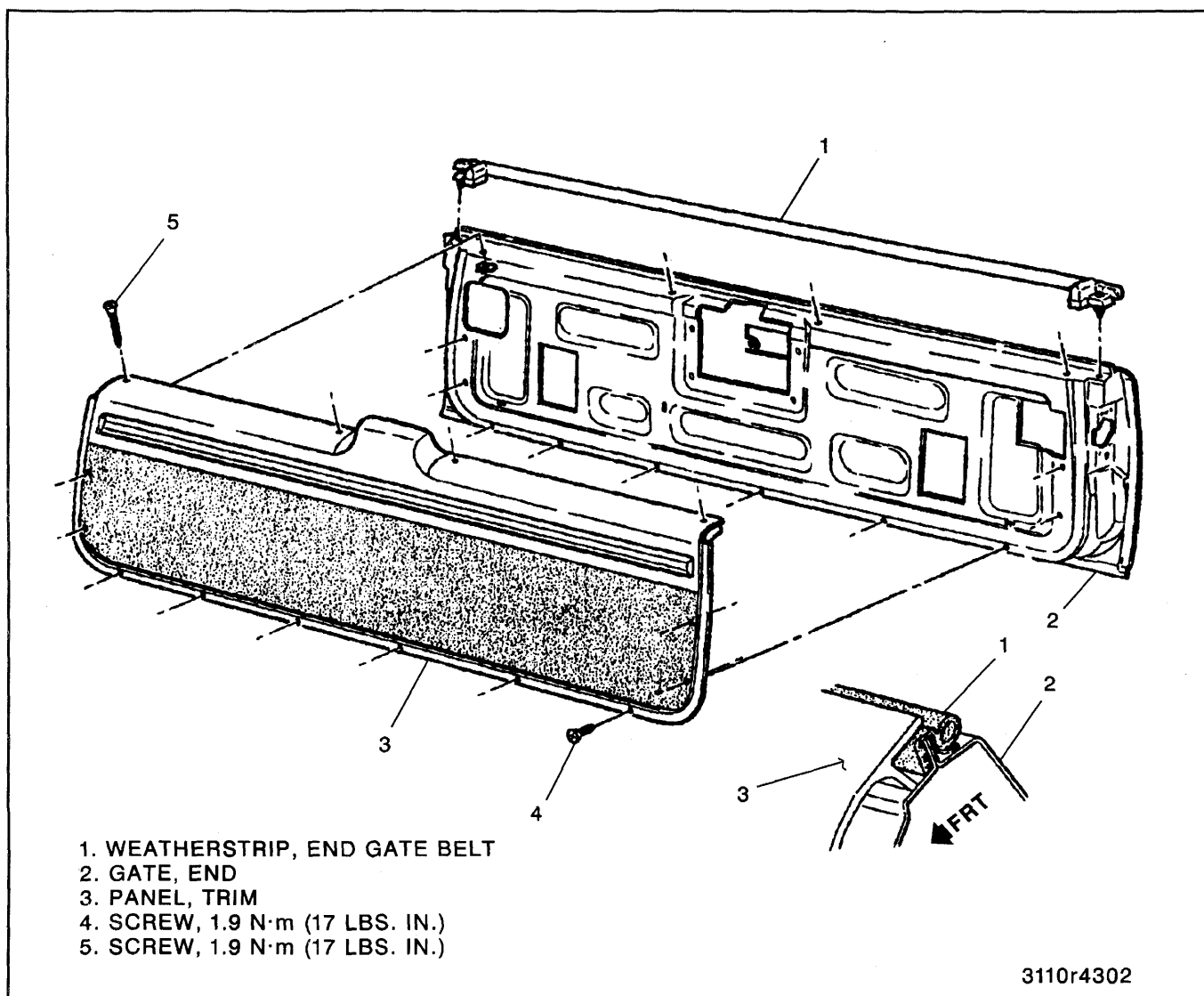


Figure 6—Trim Panel and Belt Weatherstrip

2. Trim panel to end gate screws.



Tighten

- Trim panel to end gate screws to 1.9 N·m (17 lbs. in.).

END GATE LATCH OPERATING HANDLE REPLACEMENT



Remove or Disconnect (Figure 7)

- Lower the end gate.
1. Trim panel. Refer to "Trim Panel Replacement."
 2. Lock assembly cover from the end gate.
 3. Two bolts and washers from the back of the end gate behind the handle assembly.
- Raise the end gate.
4. Handle assembly by prying gently.
 5. Latch operating rods from the clips on the handle by pushing the rods back.

6. Handle assembly from the end gate.



Install or Connect (Figure 7)

1. Handle assembly into the end gate.
 2. Latch operating rods into the clips on the handle.
- Lower the end gate.

NOTICE: Refer to "Notice" on page 10A5-1.

3. Two bolts and washers into the handle assembly from the back of the end gate.



Tighten

- End gate to handle bolts to 4 N·m (35 lbs. in.).
4. Lock assembly cover to the end gate.
- Cover must be installed with both gates closed for proper alignment.
5. End gate trim panel. Refer to "Trim Panel Replacement."

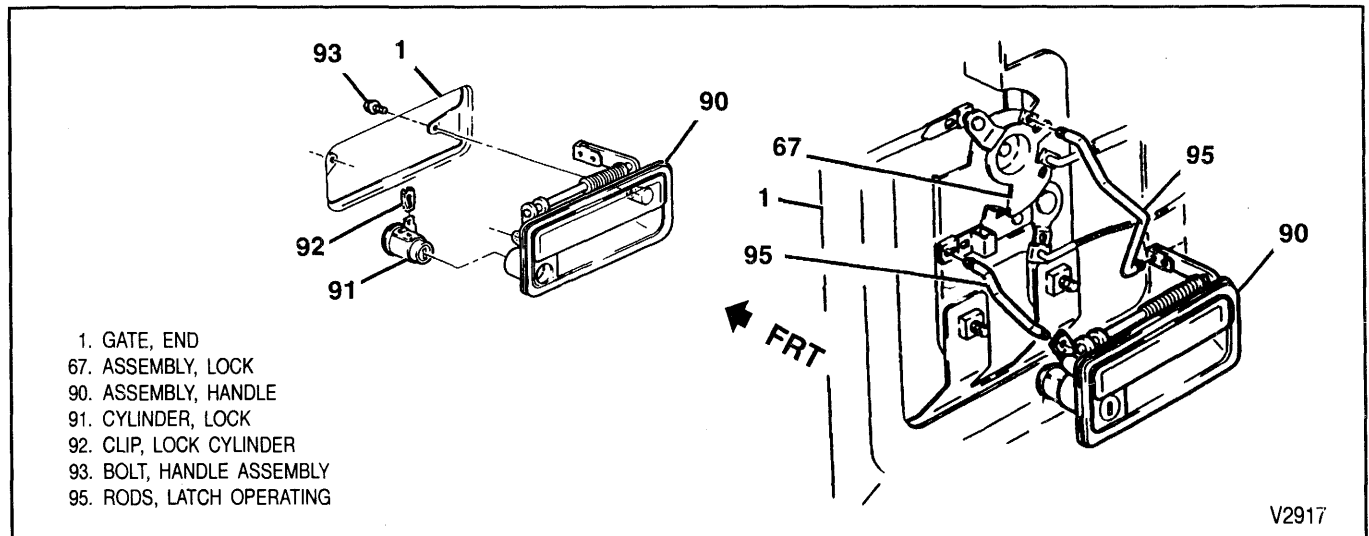


Figure 7—End Gate Operating Handle Replacement

END GATE LATCH ASSEMBLY REPLACEMENT (RIGHT OR LEFT)

↔ Remove or Disconnect (Figure 8)

- Open the end gate to the horizontal position.
- 1. End gate trim panel. Refer to "Trim Panel Replacement."
- 2. Lock assembly cover.

→→ Install or Connect (Figure 8)

NOTICE: For steps 2 and 4, refer to "Notice" on page 10A5-1.

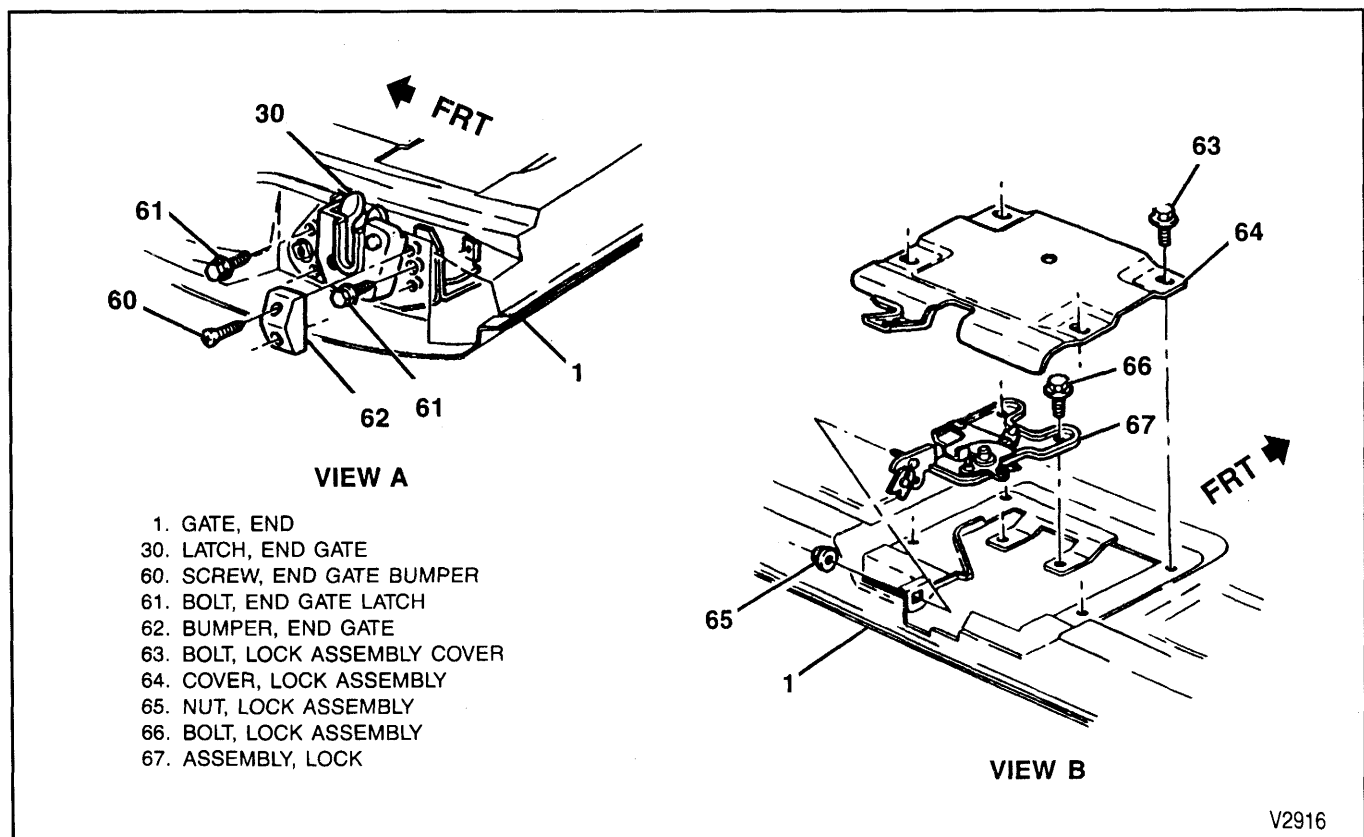


Figure 8—End Gate Latch Replacement

10A5-8 END GATE

1. Latch to the gate.
2. Bolts securing the latch to the end gate.



Tighten

- Latch to the end gate bolts to 25 N.m (18 lbs. ft.).
3. Bumper to the end gate.
 4. Screws securing the bumper to the end gate.



Tighten

- Bumper to the end gate screws to 2.8 N.m (25 lbs. in.).
5. Locking rod to the window latch.
 6. Lock assembly cover.
 - Cover must be installed with both gates closed for proper alignment.
 7. End gate trim panel. Refer to "Trim Panel Replacement."

END GATE LATCH STRIKER ADJUSTMENT



Adjust (Figure 6)

NOTICE: Refer to "Notice" on page 10A5-1.

- End gate striker assemblies up or down, forward or backward, to obtain the proper close of the end gate. The end gate should seal completely with a minimum of closing effort.



Tighten

- Striker assemblies to 63 N.m (47 lbs. ft.).

LOCK ASSEMBLY REPLACEMENT



Remove or Disconnect (Figure 8)

1. Trim panel. Refer to "Trim Panel Replacement."
2. Lock assembly cover to the end gate bolts.
3. Lock assembly cover.
4. Lock rods from the lock assembly.
 - Mark the location of the lock assembly on the end gate.
5. Lock assembly to the end gate bolts.
6. Lock assembly from the end gate.



Install or Connect (Figure 8)

NOTICE: For steps 2 and 5, refer to "Notice" on page 10A5-1.

1. Lock assembly to the end gate.
 - Align the assembly to the marks on the end gate inner panel.
2. Lock assembly to the end gate bolts.



Tighten

- Lock assembly to the end gate bolts to 15 N.m (11 lbs. ft.).
3. Lock rods to the lock assembly.
 4. Lock assembly cover.
 - Cover must be installed with both gates closed for proper alignment.
 5. Lock assembly cover to end gate bolts.



Tighten

- Cover to end gate bolts to 15 N.m (11 lbs. ft.).
6. Trim Panel. Refer to "Trim Panel Replacement."

END GATE BELT WEATHERSTRIP REPLACEMENT



Remove or Disconnect (Figure 6)

1. Trim panel. Refer to "Trim Panel Replacement."
2. Weatherstrip from the end gate flange.



Install or Connect (Figure 6)

1. Weatherstrip onto end gate flange.
 - A. Install ends of weatherstrip first by pressing fastener into end gate hole.
 - B. Push center of weatherstrip onto center of end gate flange and work out to ends.
2. Trim panel. Refer to "Trim Panel Replacement."

END GATE WINDOW STRIKER REPLACEMENT



Remove or Disconnect (Figure 9)

- Open the end gate window.
1. Striker to the end gate window pin.
 2. Striker to the end gate window bolt.
 3. Striker from the end gate window.



Install or Connect (Figure 9)

NOTICE: For steps 2 and 3, refer to "Notice" on page 10A5-1.

1. Striker to the end gate window.
2. Striker to the gate window bolt.



Tighten

- Striker to the end gate window bolt to 10 N.m (89 lbs. in.).
3. Striker to the end gate window pin.



Tighten

- Striker to the end gate window pin to 10 N.m (89 lbs. in.).

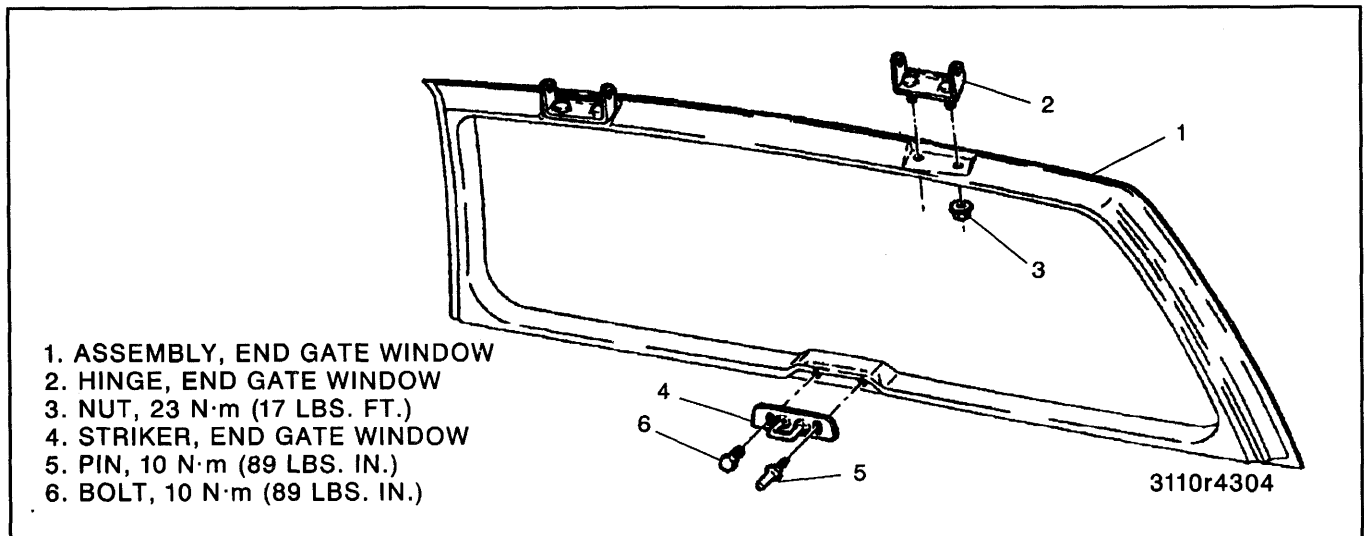


Figure 9—End Gate Window Striker and Hinge

END GATE WINDOW HINGE REPLACEMENT

↔ Remove or Disconnect (Figure 9)

1. End gate window supports. Refer to "End Gate Window Support Replacement."
2. Hinge pin retainers and the hinge pins.
3. End gate window assembly from the vehicle.
4. End gate window garnish molding.
5. Hinge to end gate window assembly nuts.
6. Hinge from the end gate window.

→ Install or Connect (Figure 9)

1. Hinge to the end gate window.

NOTICE: Refer to "Notice" on page 10A5-1.

2. Hinge to end gate window assembly nuts.

⌚ Tighten

- Hinge to end gate window assembly nuts to 23 N·m (17 lbs. ft.).
3. End gate window garnish molding.
 4. End gate window assembly to the vehicle.
 5. Hinge pins and the hinge pin retainers.
 6. End gate window supports. Refer to "End Gate Window Support Replacement."

END GATE WINDOW SUPPORT REPLACEMENT

CAUTION: Do not attempt to remove or loosen gas support assembly attachments with glass in any position other than fully open as personal injury may result.

Do not intermix original quality gas supports with other quality supports, since not all supports have the same output level.

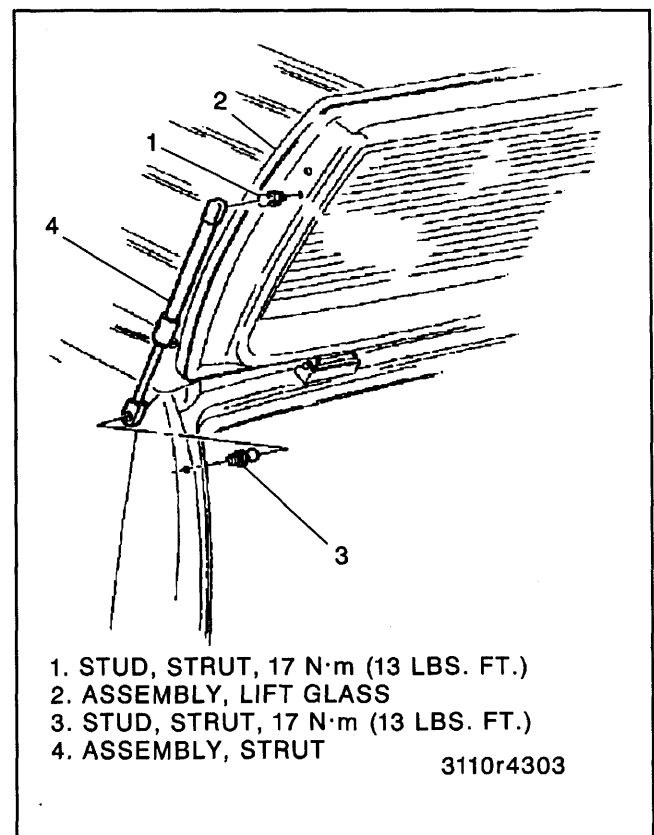


Figure 10—Window Support

↔ Remove or Disconnect (Figure 10)

1. Rear window defogger wires attached to the gas supports (if equipped).
2. Ball sockets from the glass side.
 - Carefully pry the gas support ball socket from the ball. Insert a small screwdriver between the ball and the ball socket and pull the gas support from the window.
 - Support the rear window glass.
3. Ball sockets from the body side.

10A5-10 END GATE



Install or Connect (Figure 10)

1. Gas support ball socket to the body and glass sides.
 - Push the ball socket onto the ball.
2. Rear window defogger wires to the gas supports (if equipped).

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

	N-m	Lbs. Ft.	Lbs. In.
Utility Vehicle			
End Gate Bumper to End Gate Screws	2.8	—	25
End Gate Latch to End Gate Bolts	10	—	89
End Gate Window Assembly Hinge Nuts	23	17	—
End Gate Window Assembly Striker Bolts.....	10	—	89
Latch Operating Handle to End Gate Bolts.....	4	—	35
Lock Assembly Cover to End Gate Bolts	15	11	—
Lock Assembly to End Gate Bolts	15	11	—
Support Cable to Body Bolts.....	29	21	—
Support Cable to End Gate Bolts	2.8	—	25
Torque Rod Bracket Bolts.....	15	11	—
Trim Panel to End Gate Screws	1.9	—	17
Striker to Body Bolts.....	63	47	—
Strut Stud to the Body.....	17	13	—
Strut Stud to the End Gate Window Assembly	17	13	—
Pickup			
Body Side Hinge Bolts.....	27	20	—
End Gate Side Hinge Bolts	27	20	—
End Gate Striker Bolts.....	30	22	—
Latch Operating Handle Bolts.....	25	18	—
Latch to End Gate Bolts	30	22	—

T3129

SECTION 10B

CAB AND BODY MAINTENANCE

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ON-VEHICLE SERVICE

CLEANING AGENTS

CAUTION: Follow the manufacturer's advice when cleaning agents or other chemicals are used inside or outside the vehicle. Some cleaners may be poisonous or flammable, and improper use may cause personal injury or damage. When cleaning the interior or exterior of the vehicle, do not use the following cleaners except as specifically directed in the fabric cleaning procedures contained in this manual:

- acetone
- lacquer thinners
- enamel reducers
- nail polish removers
- laundry soaps
- bleaches
- reducing agents

Never use carbon tetrachloride, gasoline, benzene, or naphtha for any cleaning purpose.

Open all vehicle doors for ventilation when any cleaning agents or other chemicals are used inside the vehicle. Overexposure to some vapors, which is more likely to occur in small, unventilated spaces, may result in a health problem.

NOTICE: To avoid possible permanent discoloration of light colored seats, do not let materials with non-fast colors come in contact with seat trim materials until these materials are totally dry. This includes certain types of clothing, such as colored denims, corduroys, leathers, and suedes.

Use the proper cleaning techniques and cleaners on the first cleaning to avoid water spots, spot rings, or setting of stains or soilage—all of which are more difficult to remove in a second cleaning.

Remove dust and loose dirt often that collect on interior fabrics with a vacuum cleaner or soft bristle brush. Wipe vinyl trim regularly with a clean damp cloth.

INTERIOR CLEANING

BASIC STEPS BEFORE CLEANING

1. Remove stains as quickly as possible before they set.
2. Use a clean cloth or sponge, and change to a clean area often. A soft brush may be used if stains persist.
3. Use solvent-type cleaners only in a well ventilated area. Do not saturate the stained area.
4. If a ring forms after spot cleaning, clean the entire area immediately.
5. Follow manufacturer's instructions for all cleaning agents.

10B-2 BODY MAINTENANCE

GENERAL CLEANING OF FABRIC TRIM WITH FOAM TYPE CLEANER

Use GM Multi-Purpose Powdered Cleaner or equivalent for this type of cleaning and for cleaning panel sections where small cleaning rings may be left from spot cleaning.

Vacuum and brush the area to remove any loose dirt and mask surrounding trim along stitch or welt lines.

Clean a whole trim panel or section. Mix the cleaner following the directions on the container label. Mix in proportion for smaller quantities. Use suds on a clean sponge. Do not saturate the material or rub it harshly. Wipe off remaining residue with a slightly damp absorbent towel or cloth. Dry the material with an air hose. A heat dryer or heat lamp may be used. Use care with a heat dryer or lamp to prevent fabric damage.

SPOT CLEANING FABRIC TRIM WITH SOLVENT TYPE CLEANER

Before trying to remove a spot or stain from fabric, try to determine the type and age of the spot or stain. Some spots or stains can be removed with water or a mild soap solution. Remove spots or stains as soon as possible.

Some types of stains or soilage, such as lipstick, inks and grease, are very difficult (sometimes impossible) to remove completely. When cleaning this type of stain, do not enlarge the soiled area. Use GM Fabric Cleaner (solvent type) or equivalent for spot-cleaning grease, oil, or fat stains.

Gently scrape excess stain from the trim material with a clean dull knife or scraper. Use very little cleaner, light pressure, and clean cloths, preferably cheesecloth. Start cleaning at the outside of the stain and feather towards the center. Keep changing to a clean section of the cloth.

After the stain has been removed, immediately dry the area with an air hose, heat dryer, or heat lamp to help prevent a cleaning ring. Use caution with heat the dryer or lamp to help prevent fabric damage.

If a ring forms, immediately repeat the cleaning operation over a slightly larger area with emphasis on "feathering" towards its center. If a ring still remains, mask off the surrounding trim sections and clean the entire area with GM Multi-Purpose Powdered Cleaner or equivalent as described earlier in this section.

REMOVAL OF SPECIFIC STAINS

Grease Or Oily Stains

The following applies to stains caused by such substances as grease, oil, butter, margarine, shoe polish, coffee with cream, chewing gum, cosmetic creams, vegetable oils, wax crayon, tar, and asphalts.

- Carefully scrape off excess matter, then use GM Fabric Cleaner (solvent type) or equivalent as explained earlier in this section.
- Shoe polish, wax crayons, tar, and asphalts will stain if left on trim; remove them as soon as possible. Use care since the cleaner may cause the stains to "bleed" as it dissolves them.

Non-Greasy Stains

This includes stains from catsup, black coffee, egg, fruit, fruit juice, milk, soft drinks, wine, vomit, blood, and urine.

- Carefully scrape off excess matter, then sponge the stain with cool water.
- If a stain remains, use GM Multi-Purpose Cleaner (foam type) or equivalent as explained earlier in this section.
- If an odor lingers after cleaning vomit or urine, treat the area with a water/baking soda solution of 5 milliliters (1 teaspoon) of baking soda to 250 milliliters (1 cup) of lukewarm water.
- Finally, if needed, clean lightly with GM Fabric Cleaner (solvent type) or equivalent.

Combination Stains

This includes stains from candy, ice cream, mayonnaise, chili sauce, and stains of unknown origin.

- Carefully scrape off excess matter. Clean with cold water and allow to dry.
- If a stain remains, clean it with GM Fabric Cleaner (solvent type) or equivalent.

CLEANING VINYL TRIM

Ordinarily soilage can be removed from vinyl with warm water and mild soap.

Apply a small amount of soap solution and let it soak for a few minutes to loosen the dirt; then rub briskly with a clean damp cloth to remove dirt and traces of soap. This may be repeated several times, if needed.

Soilage from such things as tars, asphalts, shoe polish, etc. will stain if left on trim. Wipe off these compounds as quickly as possible and clean the area with a clean cloth dampened with GM Vinyl/Leather Cleaner (solvent type) or equivalent.

SEAT BELT CARE

CAUTION: Do not bleach or dye seat belts since this may severely weaken them. Damaged seat belts are a safety hazard.

- Keep the belts clean and dry.
- Clean seat belts only with mild soap and lukewarm water.

GLASS SURFACES

Glass surfaces should be cleaned on a regular basis. Use GM Glass Cleaner or equivalent to remove normal tobacco smoke and dust films.

A non-abrasive cleaner may be used on the outside of the windshield. Clean wiper blades with a cloth soaked in a solution of one-half water and one half GM Opticlean or equivalent. A solution of one-half water and one-half methanol alcohol may also be used. Then rinse the blade with water.

EXTERIOR CLEANING

WASHING AND WAXING

Wash the vehicle in lukewarm or cold water. Do not use hot water or wash the vehicle in the direct rays of the sun. Do not use strong soap or chemical detergents. All cleaning agents should be promptly flushed from the surface and not allowed to dry on the finish.

Painted body surfaces and chrome plating should be protected by a coating of wax. Any good body wax can be used for both painted and chrome surfaces. Apply wax immediately after the vehicle has been cleaned. Periods between applications should be short enough to ensure continuous protection of the finish.

FOREIGN MATERIAL DEPOSITS

Calcium chloride and other salts, ice melting agents, road oil and tar, tree sap, bird droppings, chemicals from industrial chimneys, and other foreign matter may damage vehicle finishes if left on painted surfaces. Use cleaners that are marked safe for painted surfaces for these deposits.

CLEANING BRIGHT METAL PARTS

Clean bright metal parts regularly. Washing with water is all that is usually needed. Use GM Chrome Polish or equivalent on chrome or stainless steel trim, if necessary.

Use special care with aluminum trim. Do not use auto or chrome polish, steam, or caustic soap to clean aluminum. A coating of wax, rubbed to a high polish, is recommended for all bright metal parts.

WEATHERSTRIP LUBRICATION

Use silicone grease to lengthen weatherstrip life, to help sealing, and to help eliminate squeaks. Use a clean cloth to apply a thin film of silicone grease to all weatherstrips.

WATER LEAKS

If water has leaked into the interior, test for leak points. Refer to "Water Leak Tests" in SECTION 10A3. Mark the location(s) of any leaks.

Water which appears at a certain place inside the body may actually be entering from another point. It may be necessary to remove the floor mat, insulation, instrument panel, etc. in order to backtrack the path of the water to the point of entry. If it is still not possible to locate the point of entry, do the following:

1. Close all windows and vents.
2. Cover the air pressure relief valves.
3. Place the air lever in position to use outside air.

4. Turn the fan lever to the "HI" position.
5. Close the doors.
6. Run a small stream of water over the area suspected of leaking.
7. Check for pressure bubbles that indicate air is escaping from the interior.

CORRECTIVE MEASURES

If the leak is between body panels, use an air drying body sealing compound.

If the leak is around a door, it may be because the door is not properly aligned. Refer to SECTION 10A1 and align the door. If the door is contacting the weatherstrip correctly, make sure the weatherstrip is not damaged and is properly seated on the opening flange. If the weatherstrip is damaged, replace it.

DUST LEAKS

Dust will leak into the vehicle where water will not, particularly in the lower portion of the interior. Forward motion of the vehicle can create a slight vacuum which pulls air and dust inside.

To determine the location of dust leaks:

1. Remove the mats and insulation from the floor and toe panel.
2. Drive the vehicle on a dusty road.
3. Examine the interior. Dust in the shape of a small cone or slit will usually be found at the point of leakage.
4. Mark the points of leakage.
5. With the interior of the vehicle darkened, shine bright lamps on the underside of the floor and cowl, and have an assistant check inside for any points where the light shines through. Mark the leakage points. Check weld joints and body mounts.

Sealing of leaks should be done with an air-drying body-sealing compound.

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